MAY 12 1933

Heating · Piping and Air Conditioning

Design
Installation
Operation
Maintenance

Industry and
rge Buildings

Radio City's
British Empire Building

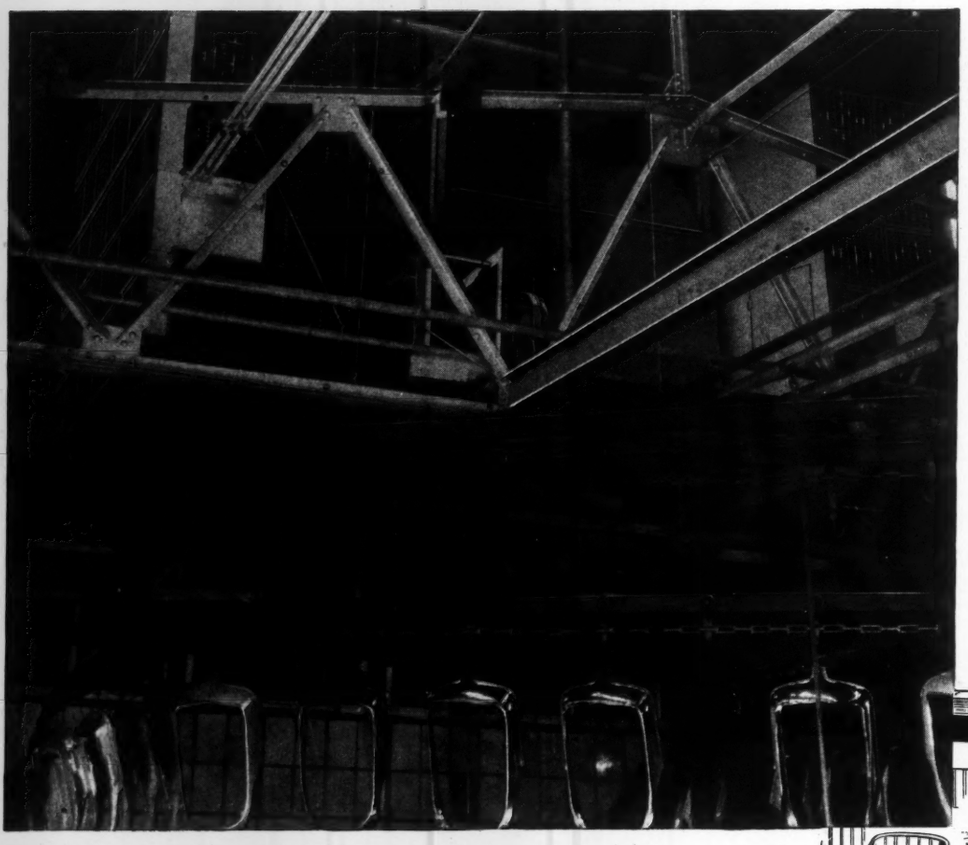
Air Conditioning in the Modern Brewery

Planning a Central Heating Plant

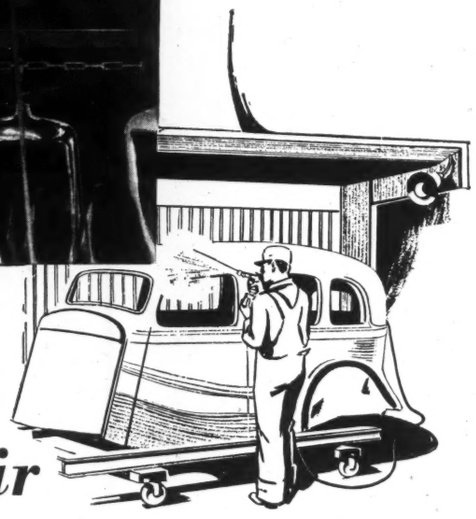
Flow of Fluids in Pipe

Journal Section of the A. S. H. V. E.

May, 1933



The Dustop Air Filter. Its light, flexible frame insures quiet operation. No cleaning. Used filters are disposed of by burning.



Plymouth *spray paints bodies in Glass-Filtered air*

Air supply for the spray painting booths and enamel room of the Plymouth plant in Detroit is freed from dust by the filter banks shown in the large illustration.

Dustop, the new Owens-Illinois glass wool air filter, solved a problem in the Plymouth plant in Detroit.

Air for the spray booths and enamel ovens is delivered (80,000 c. f. m.) from the fender grinding department directly below. An unusual volume of manufacturing dust must be removed by the filtering equipment.

The installation shown is only one of several Dustop batteries which handle a total of 200,000 c. f. m. in this Plymouth plant. 250 Dustop frames are handling this immense volume with perfect satisfaction. You will be interested in further data on the Dustop filter—by far the least costly for initial equipment and maintenance of any on the market. Owens-Illinois Glass Company . . . Industrial Materials Division, Toledo, Ohio.

DUSTOP
· Stops Dust ·

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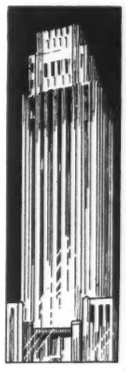
Heating · Piping and Air Conditioning

THE EDITOR'S PAGE

AIR conditioning is rapidly becoming standard equipment for office buildings, and existing structures not so equipped are finding it good business to modernize with air conditioning. One recent example is that of a New York structure, which is air conditioning six floors for one new tenant. The manager of another eastern building writes that they are "wonderfully pleased" with their new air-conditioning system.

Last summer the 17-year-old Heard office building in Phoenix, Arizona, met competition from newer structures by air conditioning. Ralph E. Phillips, the consulting engineer, gives the data on the first season's operation, including power and other costs, in an article in this issue. The air conditioning of a new building (The British Empire Building at Rockefeller Center, New York City) is described by Andre Merle this month; it is most complete.

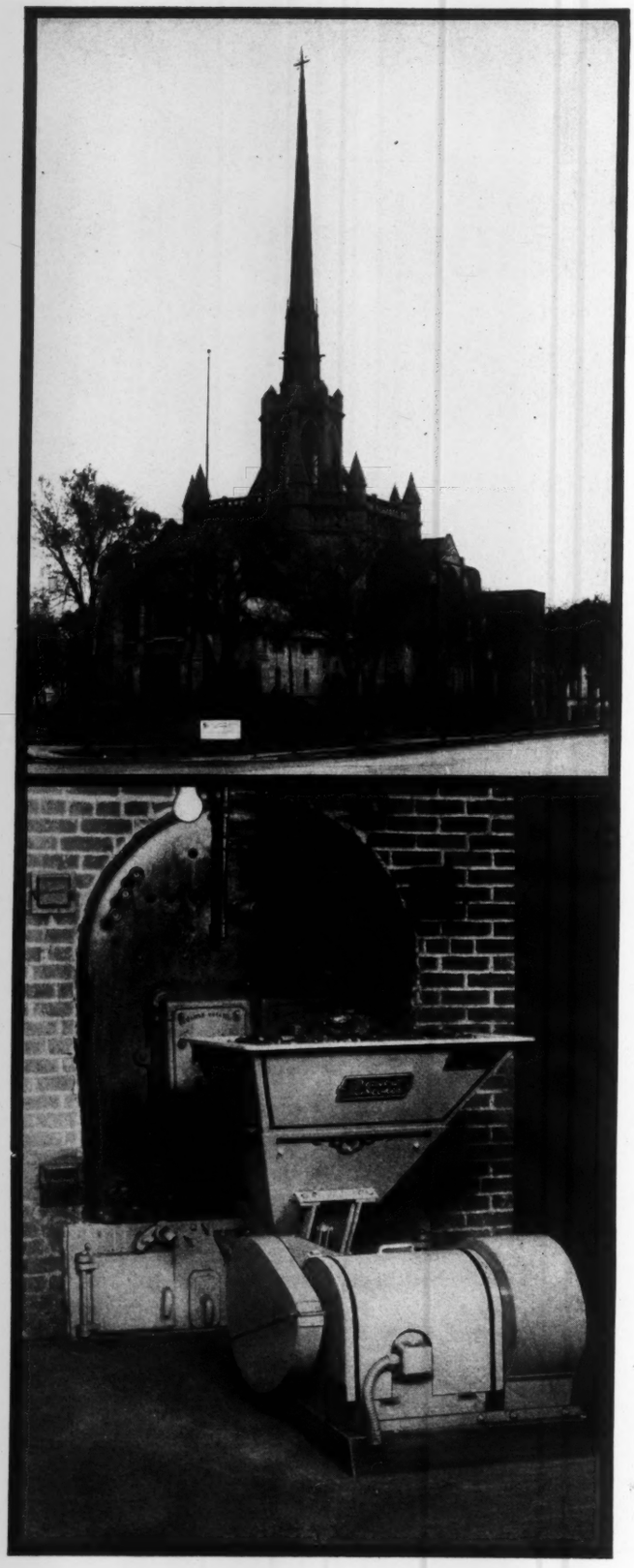
WHERE air conditioning for comfort has an immediate and readily apparent effect on income, its adoption has been rapid. Such is the case in theaters, restaurants, etc., where it is now a necessity. Rapidly are stores and office buildings coming to look at air conditioning in the same way. With the acceptance of the necessity of air conditioning for comfort, the question of economy in operation and maintenance becomes of increased importance. It is likely that greater stress will be placed on these phases of the problem.



Indicative of the value of modernizing with air conditioning to the railroads is the recent announcement by Chesapeake & Ohio of a completely air-conditioned train—the "George Washington." Each car is equipped to provide atmospheric comfort to its passengers.

COLLECTION of industrial dusts—both methods for collection and the importance of maintaining pure air conditions—is receiving considerable attention these days. Several methods are available; one is by the use of cloth screen dust collectors. In this issue W. F. Terry writes on the proper operation and maintenance of this type of equipment, and suggests a new method for proper control of the rapping of the screens.

By filtering or cleaning dust-laden air exhausted from the plant, a number of advantages are obtained. Hygienic conditions are maintained. Valuable dusts frequently can be recovered. Large fuel savings are often possible by recirculating the cleaned warm air.



a 43% saving in fuel cost

During the last two years (since the installation of the Detroit LoStoker), the Hennepin Avenue Methodist Episcopal Church of Minneapolis has reduced its coal cost by 43%. Here are the facts:

Coal Costs **before** installing Detroit Stoker:	
Winter of 1928-29	$1804.42
Winter of 1929-30	1764.76
	$3569.18
Coal Costs **after** installing Detroit Stoker:	
Winter of 1930-31	$1016.69
Winter of 1931-32	1003.67
	$2020.36
Saving made by Detroit Stoker . . .	$1548.82

The report of Mr. John M. Munn, Chief Engineer for the Church, also contains these interesting and significant statements:

"This saving can be directly credited to the stoker as there were no other changes made to the heating system.

"The savings have paid for the equipment in the two years we have already operated with it.

"We can readily carry our heating load on the one boiler and operate without smoke. The steam pressures are automatically maintained by the stoker and we feel the investment has been a very satisfactory one for the Church."

Detroit Stokers have been installed under the direction of leading architects and engineers in many other prominent religious and educational institutions. Detroit Stokers are made in a complete range of types and sizes for burning all grades of bituminous coals under all types and sizes of boilers.

Write for a copy of Bulletin 378.

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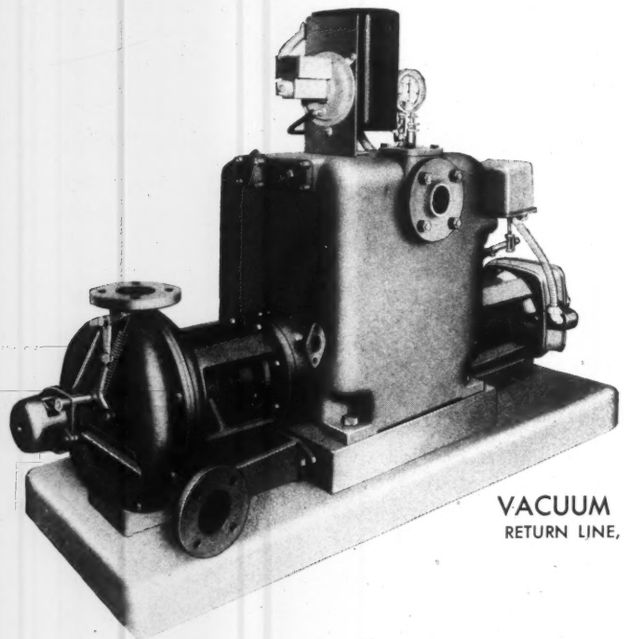
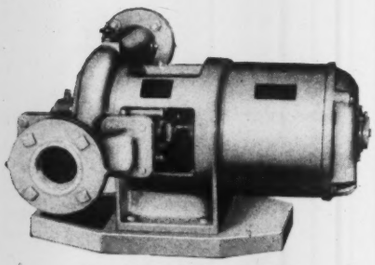
THERE IS A NASH UNIT FOR EVERY PUMPING SERVICE



VACUUM HEATING PUMP
RETURN LINE, VAPOR TURBINE TYPE



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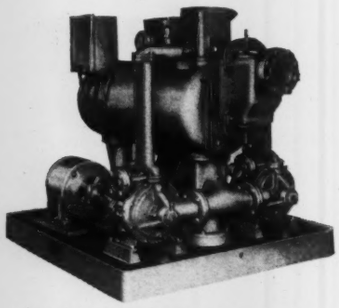
STANDARD AND SELF PRIMING
Motor armature and pump impeller mounted on same shaft. No bearings in pump casing. One stuffing box. Simple, Compact, Reliable.



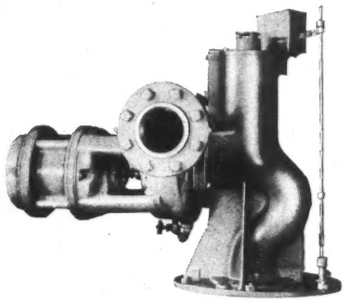
VACUUM HEATING PUMPS
STANDARD RETURN LINE
Over 45,000 installations offer testimony to the excellence of these pumps. They furnish greater pumping capacity with less horse power and at lower cost.

For over twenty years the name Nash has stood for excellence in pumping equipment. Customers who have standardized with Nash have found them to be the most economical as well as the best. Over forty-five thousand installations of the type of heating pump shown at the left of this column tell an interesting story of service.

The newest member of the Nash family is the Jennings Vapor Turbine Return Line Vacuum Heating Pump shown at the top of this page. Here is a pump which eliminates electric current, the one largest cost item in the operation of a heating pump.

For this device functions on steam directly from the heating mains, and returns that steam to the heating system. As it operates on a differential of only 5″ of mercury between inlet and exhaust the heat loss is negligible. It works equally well on any steam heating system, high pressure, low pressure, or street steam and regardless of type of steam control.

Bulletin 203 gives some interesting details concerning this economical and efficient pumping unit. Why not send for your copy?



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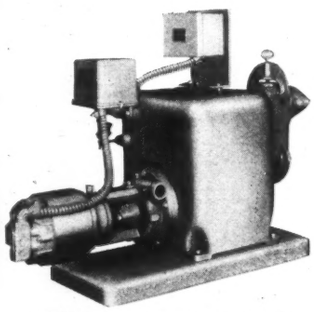

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IN UNIT AND STANDARD TYPES
Removes condensation from radiators set below boiler water line level and returns it to boiler. In Unit Type, illustrated, pump casing forms part of return tank. Construction is economical, and saves floor space.

THE NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT

May, 1933
Vol. V, No. 5

Heating · Piping and Air Conditioning

Radio City's British Empire Building

COMPLETELY AIR CONDITIONED

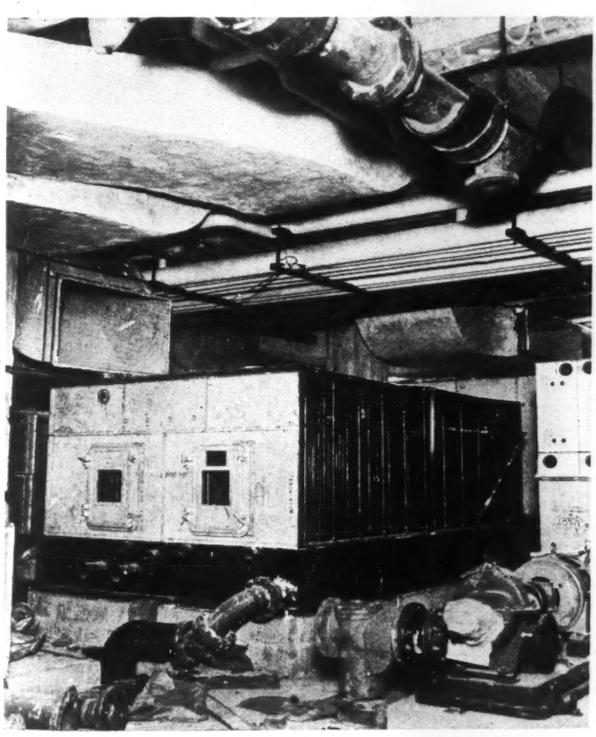
Is One Unit of World's Largest Air-Conditioning Job . . . . . By Andre Merle*

AT Rockefeller Center,[1] "America's Most Modern Building Project," in the mid-town section of New York City, is installed mechanical equipment which possesses many modern and interesting features. Complete air conditioning and sound control are included in this development, as are high-speed automatic elevators and escalators, automatic heating, scientific lighting, and modern "silent" plumbing. Design of the entire mechanical and electrical equipment has been under the supervision of Clyde R. Place, consulting engineer, assisted by his staff under the direct supervision of Ernest Williams, chief engineer and manager.

Better to visualize and acquaint one's self with this much-talked-of project, picture a development which upon completion will have installed several thousand tons of refrigeration and sufficient fans, dehumidifiers,

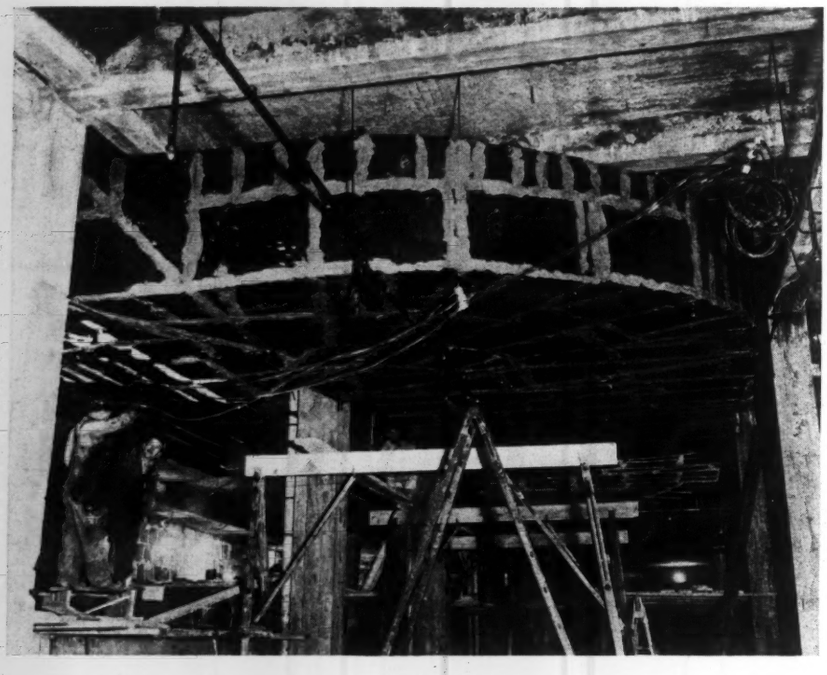
*Air-Conditioning Engineer, Staff of Clyde R. Place, Consulting Engineer, New York City.

[1]John D. Rockefeller, Jr., sponsor for the financing of this huge undertaking formed the Rockefeller Center Corporation with Col. Arthur Woods as President to direct it. The firms of Todd, Robertson, Todd, Engineering Corporation and Todd & Brown, Inc. were selected as managers. The architects were Reinhard & Hofmeister, Hood & Fouilhoux & Corbeth, and Harrison & MacMurray. The builders and general contractors of the British Building were Barr, Irons & Lane, Inc. which firm built the new Roxy Theater and are constructing the French Building at present. Baker, Smith Inc. were the contractors who installed all of the mechanical and refrigeration equipment. All engineering design, specifications and inspections were performed by Clyde R. Place and staff.



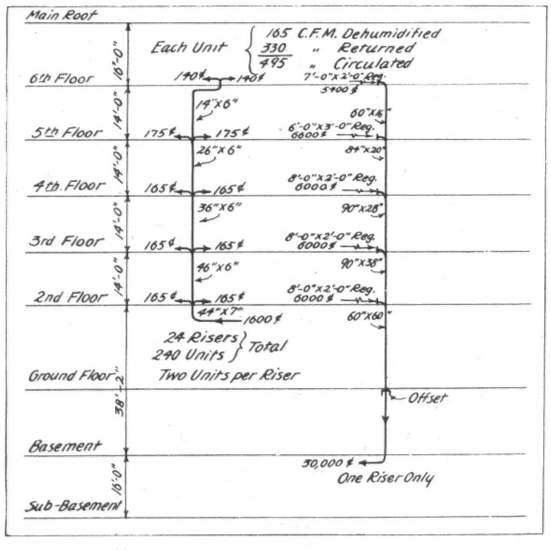
Left—Construction view showing one of the huge dehumidifiers used for conditioning the office space of the British Building

Construction view (taken January 3, 1933) of the British Empire Building (Bldg. No. 3 of the Rockefeller Center development, popularly known as "Radio City")



Construction view showing a section of the large fresh-air ducts conveying air to the conditioning apparatus in the British Empire Building

Below—Air-conditioning duct riser diagram for offices



controls and galvanized iron ducts to distribute over 200,000,000 cubic feet of completely conditioned air every hour. These quantities represent but in part the air conditioning requirements. Incidentally, they surpass in size all previous conditioning installations.

The 6-Story British Empire Building

One unit of this project is the British Empire Building, a structure dedicated to the interests of British trade and international good will and flying the colors and standards of both Great Britain and the United States. This building is now being completed for early occupancy.

It occupies the southwest corner of Fifth Ave. and 50th St. and is six stories in height, extending approximately 85 feet above street level. Below grade is a basement and sub-basement. Frontage on Fifth Ave. is 70 ft and on 50th St., 200 ft, a ground area of 14,000 sq ft. The street level and first basement will house high grade shops or stores, while the second to sixth floors inclusive have been assigned for office and display uses. The exterior finish is granite and limestone, and the roof area will be landscaped with trees, shrubbery and flowers. In its architecture and mechanical equipment the building will be as distinctive as its tenancy.

Air-Conditioning System Has Three Zones

The air-conditioning system is located in the sub-basement and is divided into three sections—basement stores, ground floor stores and office section. This arrangement provides for flexibility of operation and simplified the installation of ducts and air-conditioning apparatus. A floor area of 2,800 sq ft (40′ x 70′), with a clear head room of 14 ft houses all of the equipment, with the exception of the cooling tower on the roof. It is interesting to note that the space requirements necessary for the 300-ton steam jet water-cooling equipment which supplies refrigeration for air conditioning, do not exceed that of the more standard types of equipment.

300-Ton Steam-Jet Unit Furnishes Refrigeration

The steam-jet system of refrigeration has been utilized for a number of years chiefly in the industrial process field where it has performed satisfactorily. As applied to air conditioning its paramount value lies in its ability to produce relatively high-temperature water cooling, and to adjust and regulate its refrigeration rate quickly, so as to comply with fluctuating climatic and other load conditions. The entire cycle of operation is similar to that employed in more conventional refrigera-

tion systems, and the equipment consists of the following principal parts:

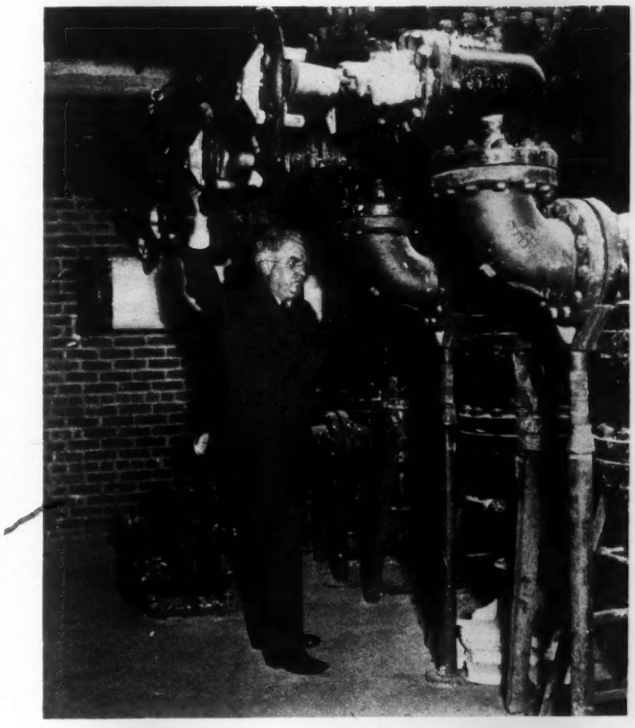
Thermo-compressors (Boosters).
Flash chamber (Evaporator).
Condensers.
Auxiliaries (Inter condensers, air cooler and condensate pump.)
Refrigerant (Water).
Steam at 125-lb pressure (from street).

A battery of six thermo-compressors or boosters, known as the primary cycle, produces the required refrigeration effect when furnished with high-pressure steam. These boosters produce and maintain the vacuum required and the ejector effect necessary to extract the excessive heat and water vapor absorbed in the dehumidification process. The boosters are of equal refrigeration capacity. With this division in tonnage and the automatic control devices, maximum flexibility of operation is obtainable. Boosters, varying in number, can be cut in or out quickly in order to meet the demand load. This arrangement provides operating economy and efficiency. As a safety precaution, a thermostatically-controlled device is installed in the flash chamber, which will cut out various boosters whenever the chilled water reaches 40 F. This prevents the possibility of freezing and unnecessary steam consumption.

A novel system of control, consisting of numerous colored lights and alarms, indicates the demand load as well as indicating the correct number of boosters required for a given condition.

The flash chamber or evaporator consists of a large, cylindrical, welded, steel plate tank, 18′ 0″ long and 7′ 0″ in diameter. Suitable baffles or water-diffusion devices are installed within the chamber so as to break the water up into a fine mist or spray. This insures rapid heat transfer and assists the booster operation. The dehumidifier spray water is chilled under a partial vacuum of 29.75 in. and the corresponding temperature of 45 F is obtained.

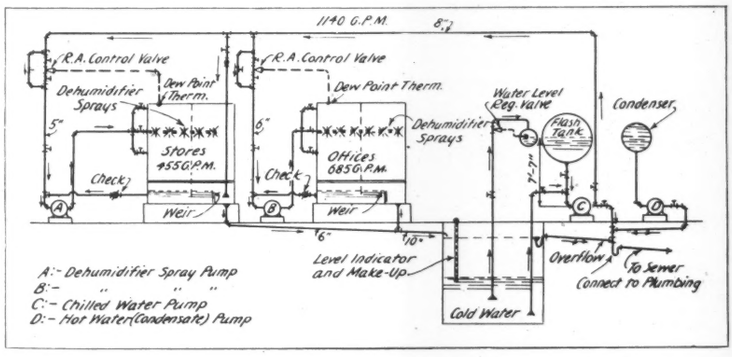
The condensers, known as the secondary cycle, are similar in operation and construction to those employed in conventional refrigeration systems. They are of the shell and tube type 20′ 0″ long and 3′ 0″ in diameter, with a capacity of five gallons per ton per minute. The condenser water extracts the heat of both the water vapor removed from the flash chamber, and that of the propelling or booster steam. A range of 20 F is utilized, with water in at 82 and out at 102.



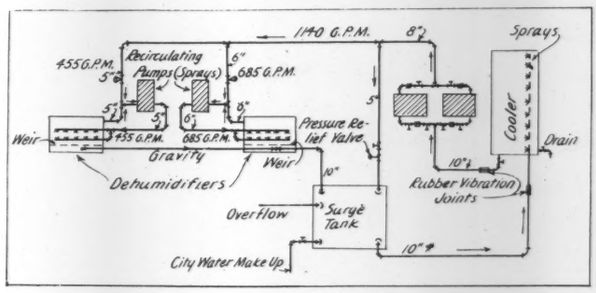
Clyde R. Place, chief mechanical and consulting engineer for the Rockefeller Center development, examining a battery of valves which control the steam supply to one of the buildings (the Music Hall) of the development

Considerable steam economy is obtained due to the inherent characteristics of the steam boosters to increase in efficiency as the outside wet-bulb temperature drops. This is accounted for in part due to the lowering of the condenser pressure ratio, and is especially noticeable when a cooling tower is employed. A special type air-cooled condenser with vacuum relief devices assists in the condensing and removal of the non-condensable gases or vapors. All of the propelling and secondary steam and water vapors, after they are

(*To page 74, back Advertising Section*)



Left—Typical chilled-water flow diagram. Below —Schematic diagram of cold-water piping



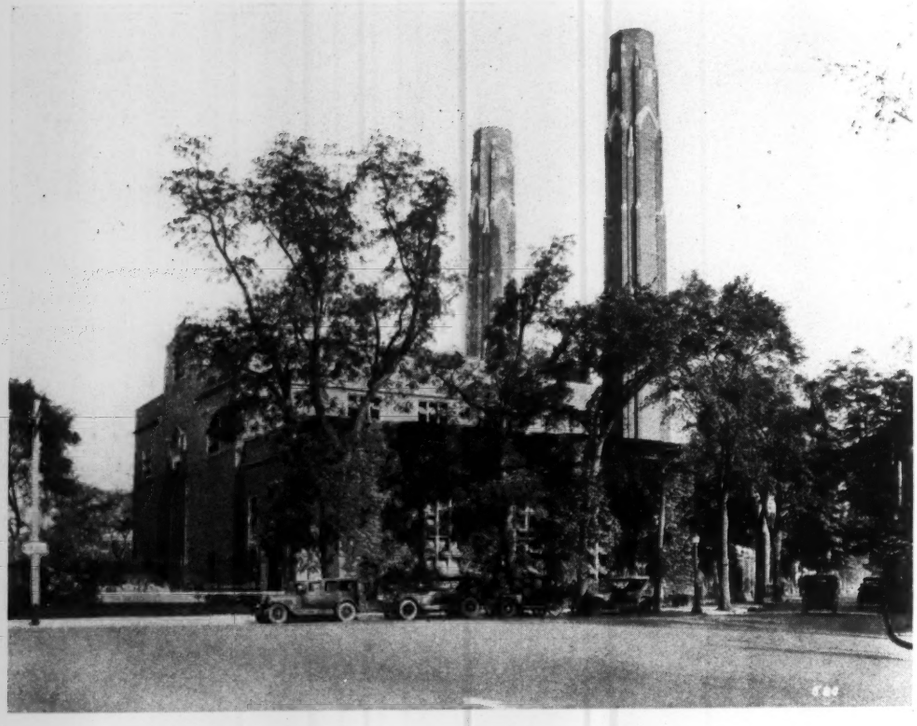


Fig. 1 (left)—With proper architectural treatment the central heating plant and its chimney will add to, rather than detract from, the surroundings

Fig. 2 (opposite) — Attractive view of a central heating plant showing skill and simplicity of chimney design

Planning a Central Heating Plant
for a School or Institution

DESIGNING a central heating plant for a group of college or institutional buildings of various ages is a complicated problem. This article outlines the points that must be considered in connection with planning the distribution of steam, choosing the pipe material, insulating the piping, etc. Combined with the article published last month devoted to locating the boiler plant, choosing the boilers, selecting the fuel, and piping the steam, it is a complete step-by-step program for planning such a plant.

The Boiler House and Stack

The boiler house and the usual equipment and arrangement of boilers and auxiliaries for a college central heating plant will not differ greatly in design from a plant of equivalent size for providing steam—and possibly electricity—for manufacturing purposes.

There should also be provided instruments for affording the operating force information as to load and combustion conditions, and provision for weighing or metering the fuel consumed. These are considered the minimum essentials to the proper operation of any plant, be it large or small.

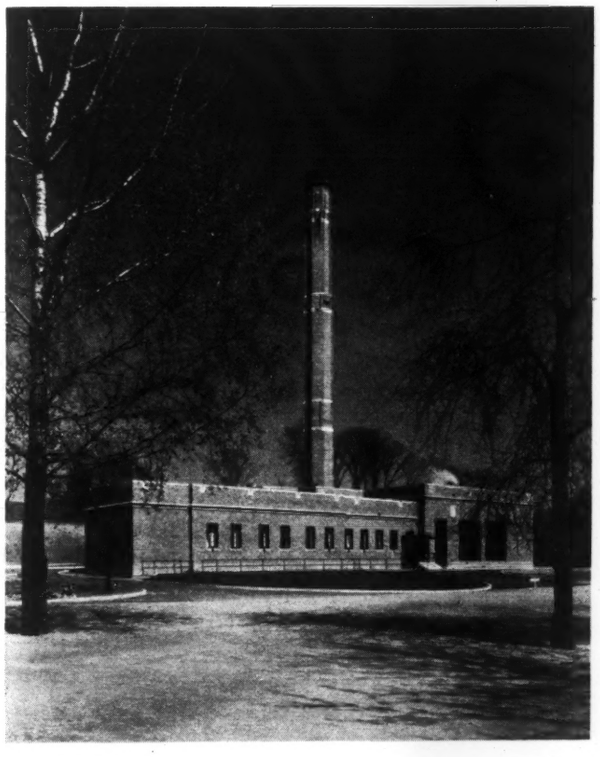
In the larger plants, coal- and ash-handling equipment, and recording instruments for both local and distant conditions of pressures and temperatures, will afford the management valuable aid in maintaining low-cost plant operation.

A chimney of considerable additional height over and above that necessary for proper combustion is quite often desirable for carrying the gases away above surrounding buildings. This is especially necessary if the boiler plant has been located at a low point on the property in order to take advantage of the gravity return of the condensation from the building heating installations to the boiler house. Neglect of this precautionary measure has, in more than one instance, led to dissatisfaction and costly changes.

A tall chimney, as usually built, may not improve the appearance of the surroundings, but with proper architectural treatment, a satisfactory solution of the problem may be effected. Fig. 1 affords an idea of how this may be accomplished with skillful design, and was employed with satisfactory results at a prominent Eastern academy. Fig 2 is an attractive view showing skill and simplicity of chimney design.

Choosing the Pipe Material

Whether steel or wrought-iron pipe shall be used is a matter for decision by the engineer. The author's present feeling is that standard-weight lap-welded steel pipe, conforming to *A. S. T. M. Specifications A53-27,* will



By . . . . . Alfred Kellogg*

serve the requirements for the steam *supply* line where steam is kept on the mains *continuously,* day and night.

If the underground piping system is to be idle for any length of time—as during vacation periods—I would incline to the use of wrought-iron pipe, and would also specify wrought-iron pipe for all underground return and drip pipes. The domestic hot-water service lines should be brass or copper, depending on the nature of the water.

In welding installations forged steel flange fittings are preferable, either standard-weight or extra-heavy, depending on the pressure.

Welding is coming so generally into use at this time that the author believes all important pipe lines should be so installed, especially in underground work.

Where the lines are to be put together with screw couplings, standard or extra heavy pattern should be employed. Pipe couplings should be "drive" pattern.

Planning the Distribution of Steam

Before planning the underground piping installation, the engineer will have decided several essential matters of steam distribution, which briefly are

1. Whether electricity is to be manufactured on the premises or purchased, or shall provision be made for the future installation of engines and generators.
2. To what extent high-pressure steam is needed for laboratory and other purposes.
3. Shall steam be supplied at high pressure throughout the system, with appropriate reduction in pressure at each of the several buildings.
4. To what extent shall the condensation from the buildings be returned to the boiler plant.
5. Shall hot water for domestic uses be provided from the central plant, or from tanks and heaters in each building.

Under the above captions, the following comments will apply:

1. If electricity is to be manufactured on the premises, it will be advisable to utilize the exhaust steam from the engines or turbines for (a) raising the temperature of the feed water makeup and returned condensation, and (b) for heating the buildings near the plant to the extent of the exhaust available, keeping in mind the possibility of future buildings that will require electricity, with consequent increase of exhaust steam.

   The exhaust may be distributed at a maximum of five pounds back pressure in the coldest weather, which represents good practice, and will permit a pressure of two or three pounds in average weather. The pipes will be sized accordingly.

   In the event of a decision to provide space only for the possible installation of an engine-generator plant at some future time, much the same procedure would be followed. Space for the larger pipes and conduits required for exhaust steam should be provided, unless the buildings to be heated from the exhaust are close to the boiler house, in which case it may be advisable to install the larger pipes in the beginning.
2. If for any reason it is deemed best to carry steam for heating at either low or exhaust pressure, a high-pressure line may be carried along in the same conduit to the points required.

   This arrangement offers the possibility and advantage of being able to deliver auxiliary steam through a proper pressure-reducing valve at one or more points in the steam-distribution system, to meet unusual demands due to weather conditions or for any other reason, without unduly increasing the back pressure on the engines, if such are to be installed.
3. Where exhaust steam is not available for heating, the present-day tendency among engineers is to install a high-pressure distribution system for all purposes, and reduce at the buildings to such pressures as may be required. This naturally results in the use of smaller pipes and consequent reduction in installation cost. It is also reasonably flexible in operation.

   A maximum pressure of 75 to 100 lb on the underground lines at the boiler plant of the larger colleges will usually be found sufficient to meet all operating conditions, and by so proportioning the pipes for delivering steam at the maximum required pressure at the *extreme* end of the underground mains, a very economical installation will be secured.

   Under such conditions a very high steam velocity will usually result, requiring careful attention on the part of the engineer to the important problem of freeing the mains from condensation. Adequate drainage must be provided at frequent intervals throughout the underground piping system, in order to avoid damage to the installation, due to the high steam velocities.

   Careful attention must also be given to pipe expansion, which may be taken care of in several ways; either by (a) pipe bends—plain or corrugated, of standard or short radius; (b) by reinforced corrugated seamless copper expansion joints, or (c) by slip joints, which require repacking at intervals.

   Expansion bends made from standard or extra-strong pipe take up considerable room and are not so generally used as formerly, except in basements or large pits built for other purposes.

*Consulting Engineer, Boston, Mass. Member of Board of Consulting and Contributing Editors.

The short-radius corrugated pipe bend occupies much less space than one made from plain pipe.

The seamless copper expansion joint occupies a minimum of space, and when welded into the pipe line, requires no further attention. The writer considers this feature of importance as the pipe lines, because of their location in the ground, are inaccessible except at pits built for drainage equipment or for other purposes.

Slip joints in such locations are invariably neglected after installation, and the fibrous or other packing employed is rarely properly maintained, resulting in a very considerable steam loss. Slip joints may be satisfactorily employed in tunnels and in open spaces, where they will be accessible for inspection and repairs.

The three views in Fig. 3 clearly illustrate installations of reinforced copper expansion joints, from which note the care exercised in guiding and anchoring the pipes. Fig. 4 shows an installation of three slip joints erected and suitably anchored in a pipe tunnel.

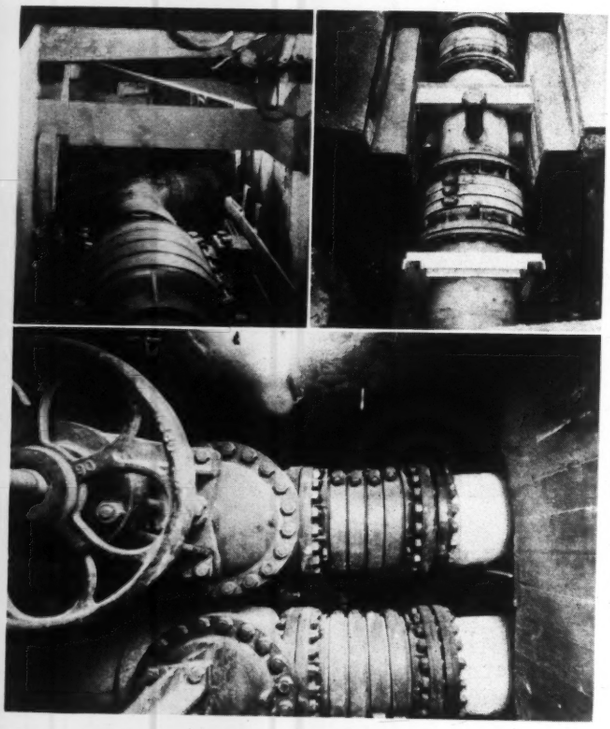


Fig. 3—Three installations of reinforced copper expansion joints; note the care exercised in guiding and anchoring the piping

4. In the small plant it will usually be advisable to return all the condensation from the buildings to the boilers. In such plants the distances from the buildings to the boiler house are not usually great, and the firemen will frequently find less difficulty in caring for the lesser number of pumps, etc., than would be the case if the condensation were wasted, and the necessary equipment of filters, possibly also water treatment devices and pumps, were installed, requiring constant attendance and greater skill in operation.

Therefore, before deciding the matter, computations of the cost of the installation of a return main, with the probable increase in the size of the conduit, the insulation, upkeep and interest charges, should be made, and compared with the cost to make steam (labor and fuel usually being considered sufficient) including the small cost of the water, if purchased. The ratio these bear to one another for the amount of condensation returnable to the boilers will determine whether it is more economical to return or waste the condensation. The average temperature of the city water may be assumed at 50 F, and of the condensation from the buildings from 150 to 175 F.

Insulation of the Piping

The insulation of piping, tanks, etc., within the buildings and tunnels should be treated as in any other building installation, but in a conduit system, the materials and workmanship must be of the highest grade if economic results are to be secured.

It is usually considered that the yearly average ground temperature at the depth of the average conduit line will be about 55 to 60 F, and this should be the starting point in estimating the pipe-line losses due to condensation.

In addition to this constant heat loss from the pipes, there is the likelihood—certainty almost—of occasional flooding of the conduits, due to heavy rainstorms, sudden winter thaws or from other causes, and much of this water will have to be evaporated from the steam mains, with consequent waste of fuel. More than this, there is the damage to the insulation surely to result unless proper design, materials and workmanship are employed in the installation.

Up to within a few years ago, a certain type of loose filler, so-called, was packed into the conduit around the pipes, and so long as this could be kept dry, it proved an efficient insulator, but with alternate wetting and drying it would finally settle and pack in the bottom of the conduit, leaving the steam pipes uncovered, and, of course, under such conditions operating efficiency was out of the question. As the result, moulded pipe covering quite generally succeeded the use of loose filler for this purpose, but a new type of fibrous filler has lately come on the market—one treated with a paraffin compound and made waterproof. Two of the illustrations in our article last month showed conduits in which loose filler is in use, and the other views of conduit installations illustrated the use of sectional covering. The choice is a matter of personal experience.

Where the conduits and steam mains are not likely to be disturbed too frequently, and the steam pressure does not greatly exceed 150 lb—also where flooding of the mains is a rare occurrence—moulded 85 per cent carbonate of magnesia makes an inexpensive and efficient covering. A laminated form of covering is indicated otherwise, and of course costs more.

After the sectional covering has been applied, in one or two courses as the case may be, it should be secured firmly with staples at the joints, and brass pipe bands or copper wire every six inches. Over this a well-lapped course of water- and fireproof felt should be cemented in place and again banded or wired.

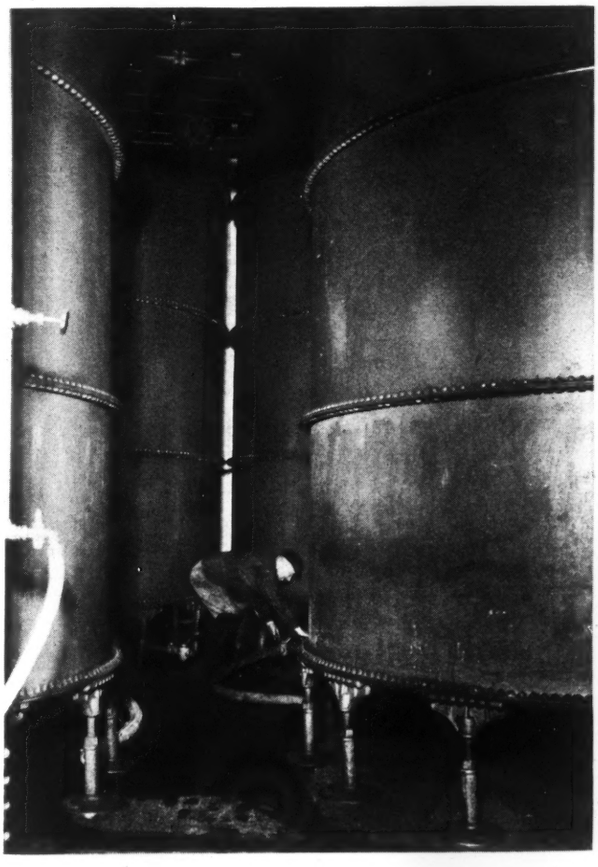
If much flooding is to be expected, a laminated insulation should be used, but in place of a layer of waterproof felt, some engineers prefer a covering of canvas with copper mesh wire woven into the fabric, and this banded

(*To page 68, back Advertising Section*)

AIR CONDITIONING *in the* Modern Brewery

By L. L. Simmons*

Some of the huge beer storage tanks in a brewery . . . Cooling is a major problem in the brewery, refrigeration being required for hop storage, fermentation, stock, racking-off, bottling rooms, etc. . . . Carbon dioxide given off in the fermentation process must be exhausted, another air-conditioning problem. . . . Bacteria-free air, to eliminate spoilage, is desirable. . . . Temperature and humidity must be controlled for yeast storage. . . . Increased thought will probably be given improved working conditions, ventilation being provided



RECENT legalization of manufacture and sale of beer in many states has resulted in a general revival of interest in brewery technique and practice. In this country it would appear that there have been no major improvements in brewery technique in the past fifteen years. Meanwhile, we have seen startling improvements in plant practice, in materials handling, and in chemical technology in all other industries. Just how these advances will be translated to the brewery is difficult to predict.

Ventilation Needed for Comfort

At the time the breweries changed manufacture from alcoholic to near beer, there was comparatively little interest in conditioning the air of manufacturing plants for the comfort of the workmen. Since that time there have been such changes that it is doubtful whether there exists any industry which does not provide in some way or another means of alleviating bad air conditions. Unquestionably there will be a demand in the beer industry for exhaust fans and other ventilating equipment. These will follow the lines worked out in other industries and need not be discussed at length here. We are interested more particularly in the problems which are peculiar to the brewery and are mainly manufacturing problems.

Cooling a Major Problem

Cooling is a major problem in many of the rooms, among them the following:

Hop Storage--about 32-40 F—a fairly high humidity desirable.

Fermentation Rooms—36-48 F—control of fermentation speed by varying the temperature.

Stock Rooms—about 31 to 36 F.

Racking-off Rooms, Bottling Rooms, Shipping Rooms—about 35 F.

A survey of these temperatures indicates direct expansion or brine coils or brine washers must be used—it is obviously impossible to use cold water. Except in very large rooms units will be used. In this connection it is well to note that except in the fermenting rooms there is apparently no evolution of heat. Fermentation produces a large amount of heat and must be taken into consideration. One figure frequently used is that the fermentation of one pound of maltose (malt sugar) into alcohol and carbon dioxide and water gives 280 Btu. This same authority states that in a five-day fermentation period there is about 28 per cent of the total heat

*Air Conditioning Department, American Blower Corporation, Detroit, Mich.

liberated each day for the first three days. Cooling has been performed in the past by lining the walls of the room with brine or direct-expansion coils. Apparently, they do not give a uniform temperature and condensation is a problem. It is customary to provide the tanks or vats with internal brine attemperating coils.

Use of Unit Coolers

One of the factors in the control of the type of beer produced is the temperature at which the fermenting beer is held. At a certain minimum temperature yeast ceases activity and above this temperature the speed of fermentation increases with every increase in temperature. In the past the temperature of the fermenting beer has been controlled by modulating the flow of brine or other refrigerant to the attemperator coils located in the beer vats and by control of the wall coils lining the room. The result has been fairly satisfactory from a manufacturing standpoint, but has hardly been conducive to good housekeeping. The lack of air circulation has resulted in spotty cooling and condensation, and the defrosting of wall coils has in many cases resulted in bad moisture conditions. It is highly probable that the internal attemperator coils will be retained, but that unit coolers, with either brine or direct expansion coils, will gradually replace the old wall coils. It is estimated there will be some saving in first cost, but the main advantage of this change will be in maintaining more uniform temperatures and in providing means by which the water from defrosting can be readily removed and handled.

Exhausting Carbon Dioxide Gas

During the fermenting process there is a large liberation of carbon dioxide gas. In the past this has been handled by providing louvered openings on as many sides of the fermenting room as possible, endeavoring to keep down the carbon dioxide concentration by natural ventilation. This has been variable in action and wasteful of refrigeration. The modern brewery fermenting room should have forced ventilation by a small exhaust system removing the carbon dioxide gas near the floor level, where (on account of its high density as referred to air) the concentration is highest.

In the cooking rooms and in the first section of the wort-cooling coils there is a large evolution of water vapor. This will be handled according to practice in other industries, either by hooding in conjunction with exhaust fans or by the use of a vapor-absorption system as is used in paper-mill work.

Need of Bacteria-Free Air

There have been in the past many cases of beer spoilage where the trouble could not be definitely allocated to any particular cause. It is highly probable that many of these cases have been due to foreign bacteria introduced with the incoming air, particularly in the wort-cooling rooms where the wort, both because of its temperature and the surface exposed, is in an especially vulnerable condition. Modern research shows most bacteria to be dust-borne and a proper combination of air filters and washers should materially decrease this source of spoilage. There has been a good deal of interest shown in this phase already.

Close Control of Yeast Storage

Unquestionably there are many other requirements for air conditioning in the brewery. Certain patented processes for the production of beer, where the entire process is accomplished in one vessel or a connected series of vessels, may offer a fertile field for the air conditioning engineer and contractor. The yeast storage offers good possibilities for the installation of air-conditioning apparatus of the industrial type, where the temperature and humidity are controlled absolutely within narrow limits.

Malting the Grain

In most instances, the malt house, except in the case of the larger breweries, is a separate institution. Barley is the grain generally malted, although some other grains have been used. The malting process consists in its elements of these operations: After cleaning, the grain is steeped in water, drained, then allowed to germinate in an atmosphere of about 60 F until the husk is about to be broken. At this point the *green* malt is dried and then kilned at temperatures starting at 90 F and finishing at 150 to 220 F, depending upon the type of malt desired.

Modern malting is performed in one of two ways—on a perforated floor or in very slowly revolving drums. In the first method tempered air is blown up through the floor while the malt is agitated by mechanical rakes or screws; in the second, the revolving drum does the agitating while the air is blown through the trunnions. In the old plants the air is washed in a coke tower washer and heated by pipe coils. There seems to be no reason why air washers and extended surface blast heaters should not be used.

The drying and kilning of the malt is usually performed in dry houses which consist of two or three perforated dumping floors. Heat is furnished by a coke-fired furnace and the products of combustion are drawn upward through the floors in series by a fan located above the top floor. The green malt is placed on the top floor where the temperature is 90 F and kept there until partly dry. It is then dumped to the second and then the first floor and exposed to increasing temperatures. Mechanical agitation is used. The fan handles gases at about 100 F and must be well painted to resist corrosion from carbon-dioxide fumes and sulphur dioxide from the sulphur which is occasionally placed on the fire to kill bacteria.

Other fan and heater applications in the malt house are common to normal industrial plants.

Increased Need for Air Conditioning Probable

In addition to the possibilities as outlined, there exists all the normal heating and ventilating problems as found in other industrial plants. It is to be expected that, in an industry which has been somewhat dormant for a period of years while other industries have made rapid strides, there will be in the future some rapid and possibly radical changes in procedure. It is highly probable that following the trend in the chemical and food industries these changes will involve close control of temperature and humidity conditions and an increasing use of air conditioning.

More About

Leak-Tight Joints—600 to 550,000 Lb

SEVERAL letters referring to the article "Leak-Tight Joints—600 to 550,000 Lb," by F. E. Wertheim (HEATING, PIPING AND AIR CONDITIONING, July, 1932, p. 469, and Aug., 1932, p. 546) have been received. We believe the following extracts will be of interest.

To the Editor:

We have looked over the articles on high-pressure joints, and wish to state that, in general, they cover details of which we approve. The following comments may be considered as complementing the information given in the articles, rather than as a criticism.

Our general attitude is that high-pressure joints at best are troublesome and we endeavor to reduce their number as much as possible. Thus, in high-temperature work we avoid joints wherever possible by combining parts in casting or welding. The practice of seal welding joints will probably become more and more common.

We have not had very satisfactory success with the *A. S. M. E.* standard for 600 lb per sq in. joints for small sizes. This calls for the flange to be fitted to the pipe on a loose straight thread, the flange acting as a strong back and the end of the pipe fitting into a recess in the other member of the joint. Fig. 8, on page 472 (July, 1932) presents a similar construction.

—C. Richard Soderberg.[1]

To the Editor:

We read the article by F. E. Wertheim with a great deal of interest. Our only comment is that no mention has been made of the use of welded pipe joints. In view of the large usage of welding for providing satisfactory joints under a great variety of conditions and a wide range of pressures and temperatures, it appears to us that a section of the article could have well been devoted to this modern type of construction.

Having followed the development of welded pipe joints and noted the increasing use of this method over a number of years, it is our opinion that eventually welding will supplant practically all other types of joints. The notable exceptions will be where it is necessary to have a type of joint which can readily be taken down and reassembled.

Mr. Wertheim mentions the weld-seal joint, but this should be considered, of course, as an adaptation of the flange joint since the weld itself is not called on to supply strength, but is merely to make the joint leak-proof.

To my personal knowledge at least one well known industrial concern in this country is using the welded joint at pressures up to 15,000 lb per sq in. and have found it the most satisfactory type of construction they have been able to develop. Acetylene welded joints are made in 4 in. O.D.—1¾-in. I.D. tubing. Both pipe ends are beveled and the weld metal is laid on in three layers, after which the joint is annealed and tested hydrostatically to 35,000 lb. This is not an experimental proposition, but is in regular daily use.

We shall be very glad to receive a summary of opinions which may be expressed by others.

—G. Fred Sherman[2]

[1]Turbine Apparatus Division Engineer, Westinghouse Electric & Manufacturing Company, South Philadelphia Works, Philadelphia, Pa.

[2]Sales Manager, Forged Fittings Division, Bonney Forge & Tool Works, Allentown, Pa.

Comments by F. E. Wertheim[3]

Thanks are due Mr. Soderberg for giving the benefit of his experience to other engineers.

With reference to 600-lb W.S.P. Type "A" joints, we can compute gasket pressures as follows:[4]

$$\text{Gasket Pressure} = \frac{\text{Initial Stress} \times \text{Bolt Area}}{\text{Bearing Area of Gasket.}}$$

The initial stress may be assumed to be in accordance with the formula: $t = \frac{30{,}000}{d}$ (see "Piping Handbook," page 345). Computations will show that gasket pressures are unduly high, ranging from 47,600 lb per sq in. for a 4-in. joint to 170,000 lb per sq in. for the ½-in. size. Therefore, unless excellent judgment is used in bolting up, gasket pressures are likely greatly to exceed the yield point of seamless open-hearth pipe material. Perhaps the difficulties indicated by Mr. Soderberg may be explained in this way.

There is, of course, considerable similarity between the "Type A" joint mentioned and the Benson which was shown in my article (Fig. 8, page 472, July 1932), but there is likewise an important difference, *i. e.,* the longer bolts, the helical springs, and steel lens gasket of the Benson joint. In such joints, troubles are probably due more to high temperatures than to high pressures. The springs compensate for creep stresses and for the larger temperature variations; they are said successfully to eliminate trouble.

Mr. Sherman's points are indeed well taken, as he imparts enlightenment pertaining to special conditions with which many are unfamiliar.

My article was intended to apply only to detachable connections. Many engineers now believe that all flanges should be replaced by welded construction, and advocate welded connections for valves, for boiler drums, and for turbine piping. Now that fusion welded boiler drums have won acceptance, elimination of flanges may not long be considered too radical a step. Those who are interested in the subject of welded fabrication for high pressure and high temperature steam lines for power plants may find a thorough analysis in F. W. Martin's paper, read before the *International Acetylene Association,* at the Chicago meeting, Nov. 11, 1931.

At the time the article on leak-tight joints was written, permission to present information concerning the new type joint known as the "lock head" was withheld.

[3]Member, *Western Society of Engineers,* Chicago, Ill.

[4]See page 256, HEATING, PIPING AND AIR CONDITIONING, April, 1932.

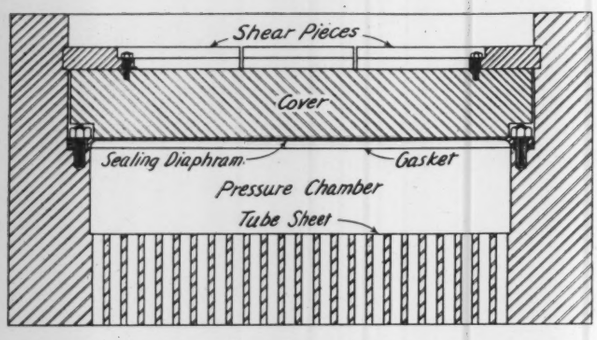


Fig. 1—Diagrammatic drawing of high-pressure lock-head type joint applied to a reheater steam chest. The load is carried by the very heavy cover plate which in turn bears against the shear pieces. The load is placed on the cover piece by a thin and flexible diaphragm, which does not carry any load but transmits it to the cover. The only pressure load which the studs must carry is that transmitted by the small area which the gasket closes. The gasket is a rather narrow, large-diameter annular gasket pinched between the flange of the diaphragm and the main body of the head

Fig. 1[5] shows this development, which is intended for high-pressure heat exchangers, boiler drums, and other power plant apparatus. Heaters about 30 in. I.D. for working pressures up to 1,800 lb are in service. In this joint the load thrust is carried by shear blocks, and tightness is secured by a diaphragm gasket. Heavy bolting is eliminated and neither heating of bolts nor slugging of nuts is necessary; both bolting up and disassembling are easy and rapid because bolts are only from ½ to 2 in. in diameter. (The 2-in. size is used for working pressures above 5,000 lb.) Variations in temperature do not have any tendency to cause leakage because the studs which clamp the gasket are not affected by expansion or contraction of heavy parts, nor are they affected by load thrust. This joint is more compact than the bolted type; furthermore, it requires less working space because no long handled wrenches are required in making up joints.

[5]From "Heat Engineering," Dec., 1932, published by Foster Wheeler Corporation.

Improved Piping Arrangement for Operating a Damper Regulator

By W. H. Wilson*

THE damper regulator for controlling the draft of the furnace of a steam boiler is usually operated by the steam pressure. Briefly, when the pressure reaches a predetermined point, this pressure operates the damper regulator (usually by the piston of a hydraulic cylinder, in connection with pulleys, cable, levers and weights), mechanically closing the damper in the duct leading from the boiler furnace to the smoke stack. When the steam pressure goes down the operation is reversed and the damper regulator opens. Some types of damper regulators are loaded with a column of mercury, the static head balancing the steam pressure. The steam pressure is the power for operating the damper regulator, which in turn controls the furnace draft.

The piping for transmitting the steam pressure for operating and controlling the damper regulator is usually connected to the main steam header, in order to get a steady pressure, free from fluctuating and pulsating variations.

It is usual practice to equip boilers with an automatic header valve that will close automatically when the steam pressure is suddenly reduced inside of the boiler, as for example when a boiler tube bursts. Certain types of these automatic header valves have additional features: The valve will also close and remain closed when the main steam header or a branch pipe line breaks and causes a sudden and noticeable reduction in the steam pressure, preventing an outflow of steam from the boiler. These are usually termed triple-action valves; that is, they close with a back flow of steam, they will close with an outflow of steam that causes a sudden reduction in the pressure, and they can be closed manually by the hand wheel.

The installation of valves of the triple-action type is often recommended. One reason for this is the matter of safety. Broken steam mains usually cause trouble and damage to property, sometimes loss of life. Another is that a broken steam main means a corresponding drop in the boiler steam pressure, which relieves the pressure on the water in the boiler, causing it to evaporate into steam at a lower temperature. In the midst of the confusion, excitement and general all 'round disorder in the boiler room when it is necessary to climb to the top of the boilers to close header valves in such an emergency, the engineer is confronted with a disappearing water-line in his boiler gage glasses.

Header valves of the triple-action type will close and keep the steam in the boiler in such a situation, unless the pressure rises and the steam is relieved by the safety valves.

Location of Connection to Damper Regulator

The purpose of this article is to call attention to the importance of connecting the piping that supplies the steam pressure to operate the damper regulator at the proper point. If this pipe is connected to the main steam header beyond the triple-action valves, the following may result:

When the main steam header or a pipe line outside of

*Member of Board of Consulting and Contributing Editors.

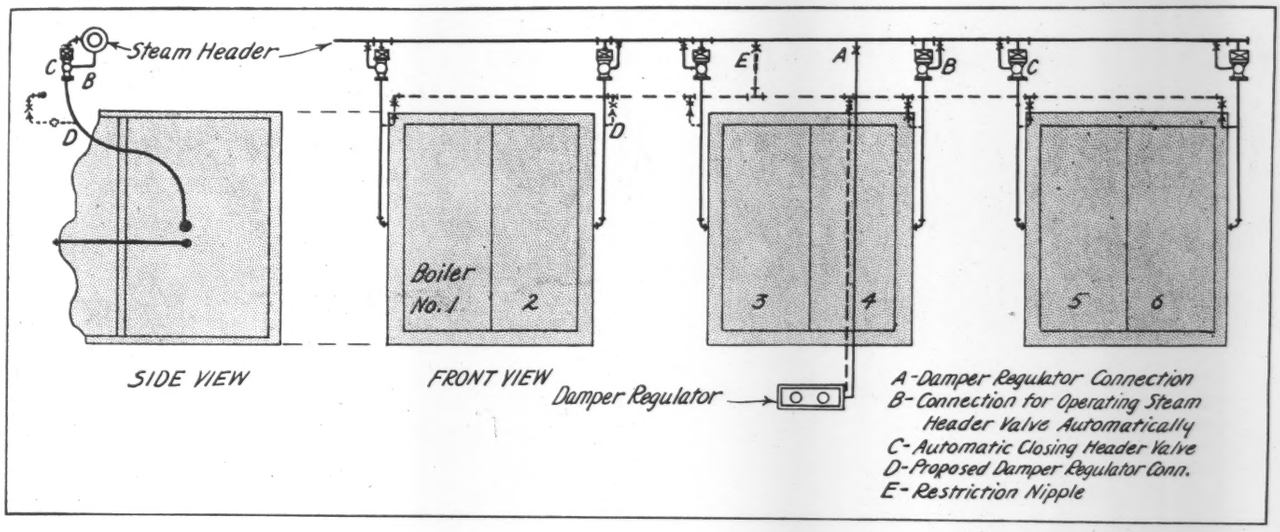


Fig. 1—The dotted lines show an improved arrangement of the steam connection for operating a damper regulator controlling the draft of the furnace of a steam boiler

the boiler house breaks there will be a sudden reduction of steam pressure. The triple-action valves will close promptly, the small pipe connection *B* (see Fig. 1) operating the closing mechanism of certain types of these valves. The steam pressure in the main steam header, unless supplied from another source, will continue to drop, which affects the damper-regulator operating steam supply and causes the damper regulator to open and remain open. This in turn will give draft to the fire and produce more steam, causing the safety valves to discharge the excess steam.

The dotted lines in Fig. 1 show a better arrangement for the damper-regulator steam connection; this consists of an auxiliary line for supplying the steam pressure for operating the damper regulator independent of the main steam header.

The steam supply connection is taken off between the automatic header valve and the boiler. As any boiler may be out of service temporarily, a connection is made to each boiler in the battery. To prevent steam from passing into boilers that are not steaming as rapidly as others, a check valve is placed on each boiler branch connection to this auxiliary line, to prevent equalizing of the steam and interfering with the metering of the steam, if meters are used. This will also automatically close off when the boiler is taken off the line. The check valves will have a tendency to hold the steam pressure in this auxiliary line and not allow the damper regulator to adjust itself promptly to a reducing steam pressure in the boilers. In order to overcome this, a connection *E* is made to the main steam header which has a nipple with a restricted opening allowing a small amount of steam to pass out of the auxiliary line into the main steam header and equalize the pressure in the damper-regulator operating line with the main steam header and insure the proper pressure, at all times, to be supplied to control the damper regulator. When the main steam header pressure is lowered in an emergency and the header valves automatically close, this leakage of steam through the restricted port will not affect the proper working of the damper regulator.

A stop valve and a union connection is also placed on each boiler branch connection of this auxiliary line. When a boiler is taken out of service it can be closed off to prevent possible injury to men who may be inside the boiler. It is safer to disconnect the union connection before entering the boiler.

The check valve, stop valve, union, fittings and pipe should be of a good quality and of a type suitable for the steam conditions.

The arrangement of piping shown requires additional pipe, valves, fittings and attention, as compared with the pipe connection direct to the main steam header. The author believes this extra care is worth while, however.

Industrial Piping "Case Book" Published

Industrial Piping—A Case Book of Proven Methods. Engineering Publications, Inc., Chicago. 279 pp. $3.50.

This book is a selection of the articles on industrial piping which have been published in HEATING, PIPING AND AIR CONDITIONING. Its value lies in the fact that it has been written by men who are daily solving the problems of industrial piping; and, further, in that the data given represent a combination of theory and practice.

The twenty-three chapters of the book cover, briefly, an introduction to the subject of industrial piping, a new series of tables for economical steam pipe sizes for heating, process and power steam, pipe bends, design of piping for process plants, for high-temperature lines, for a mile-long underground line; steam coil installation, the economical thickness of insulation, the handling of viscous liquids, trap installations, air piping, refrigeration piping, the advantages of modernization, etc. Numerous drawings, charts and tables, and an index aimed at making reference easy and convenient are included.

One of the contributors to the book said: "First cost is not final cost—and it is final cost which determines profit." The whole plan of the book has been to present a selection of helpful data in which theory and experience are fused, as a guide toward that final cost which determines profit.

17-Year-Old Office Building Meets Competition by Air Conditioning

. . . Consulting Engineer Gives First Season's Operating Data

By Ralph E. Phillips*

SEVENTEEN years ago, when the Heard office building was constructed in Phoenix, Arizona, air conditioning for commercial structures had not been developed as at present. No provision was made for ventilating the general office spaces but a small washed air system was installed in the basement pressroom and second-floor linotype room of the newspaper plant which occupies about 25 per cent of the building on a long-term lease.

With the development of air conditioning systems for commercial buildings during the past ten years, several new buildings in Phoenix have been completely equipped to guarantee comfortable temperatures and air conditions to their tenants.

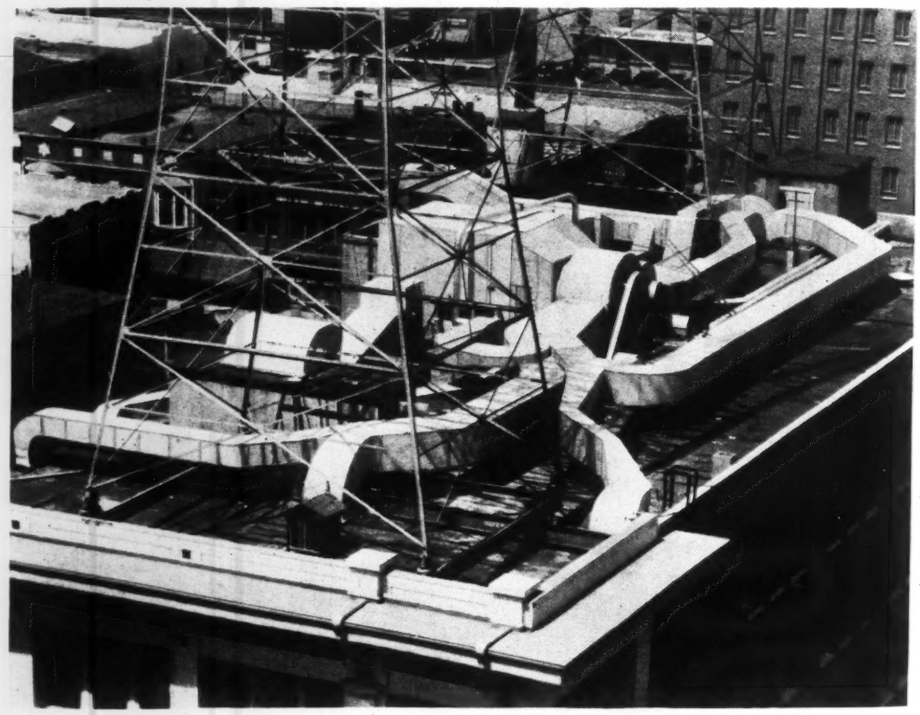


Fig. 1—Nowhere throughout the 17-year old office building was space available for the fans, dehumidifiers, or main horizontal ducts so this equipment was put exposed on the roof; all surfaces are insulated. Chilled water lines from the refrigerating plant in the basement run exposed on the rear wall of the building to the dehumidifiers. Parts of the roof were reinforced

These modern air-conditioned buildings placed such structures as the Heard building in a very disadvantageous position, so it became imperative for the owners to find some way of air conditioning the Heard building with a system that would be economical from an installation and operating standpoint, as even after the Heard building had been air conditioned, it would still be a 17-year old building competing with new structures in the same city and therefore could not earn the revenue per sq ft of rentable space that they could.

Another point that required consideration was that the air-conditioning system would have to be installed with the least amount of discomfort and annoyance to the tenants of the building, making it necessary to do much of the work at night.

That the modernization of the Heard building with air conditioning (which was completed last June) has proved advantageous is evidenced by a letter received from E. W. Larson, Secretary, the Dwight B. Heard Investment Co. He says: "This system has been entirely satisfactory from our standpoint. The problems involved in the installation of this system in a building already built and occupied were overcome in a manner satisfactory to us and we believe to all our tenants. Results from a standpoint of relative humidity, temperatured and air volume have been in every case as good or better than the specifications called for."

Little Space in Building; Equipment on Roof

The Heard building is six stories—and basement—in height, with reinforced concrete frame and brick filler walls. A general survey by the air-conditioning engineer indicated that a basement space approximately 20 ft by 30 ft was available for the refrigerating plant but

*Consulting Engineer, Los Angeles, Calif.

that nowhere throughout the building was there space for fans, dehumidifiers or main horizontal ducts. It was therefore necessary to place this equipment exposed on the roof of the building, covering all surfaces with an insulating material. Portions of the roof had to be reinforced between column centers in order to carry the additional weight of dehumidifiers and fans.

Air-Conditioning System Zoned

The system is zoned in two units of fans and dehumidifiers, in order to control temperatures on the north and east walls separately from the south and west walls; the ducts supplying the east wall are separated from those supplying the north wall, as is the case with the south and west walls. At the point of separation of these main ducts, automatic damper control is installed to supply more air to the wall having the sun exposure.

Five spaces were found available through the typical floors adjacent to the public corridors for running main supply risers and two spaces were made available for running return vertical ducts. At each floor level, the supply ducts branch at the corridor ceiling and terminate in the offices at the corridor wall with supply registers. Return is by open transom over door through the public corridors to the return registers at each return shaft. This method of air distribution required the least amount of cutting and patching and, with the exception of cutting through the corridor walls to the offices for register openings, the tenants were in no way discommoded. However, this method required the hanging of new plaster ceilings in the public corridors.

Those parts of the newspaper plant which operate 24 hours a day are supplied by the air-conditioning system between 7 a. m. and 6 p. m. and are supplied from the old reconditioned washed air system during the night by a cross-connected duct system.

The total conditioned air supply is 61,000 cfm with 80 per cent recirculation, or approximately 49,000 cfm return air. This entire plant, including all air conditioning equipment, cutting, plastering, patching and painting, was installed for approximately $43,000.

150-Ton Compressor Supplies Refrigeration

One 150-ton horizontal reciprocating ammonia compressor, with shell-and-tube cooler and shell-and-tube condenser, furnishes refrigeration. Condensing water is obtained from a 600-gpm well and is returned to the ground at the opposite corner of the building through a return well system. Chilled water lines from the cooler in the basement run exposed on the rear wall to the dehumidifiers on the roof.

With this closed cooler arrangement, the pumping head required is friction, 25-lb nozzle pressure and approximately 8 ft static head. At each dehumidifier a three-way valve arrangement mixes the chilled water and the warm pan water to meet the required conditions in the particular building zone.

Complete Operating Logs Kept

With this general description in mind we are ready to deal with the operating and economical phase of air con-

(*To page* 66, *back Advertising Section*)

OPERATING LOG, HEARD BUILDING

Phoenix, Arizona. Date 8/6/32

TIME	Water on Condenser	Water off Condenser	Condenser Pressure	Temp. Liquor off Condenser	Discharge Temp.	Suction Temp.	High Back Pressure	Low Back Pressure	Water to Cooler	Water off Cooler	Temp. Water No. 1 Pump Header	Temp. Water No. 2 Pump Header	G. P. M. Water to Condenser	G. P. M. Water to Cooler	Clearance Pocket No. 1 Open	Clearance Pocket No. 1 Closed	Clearance Pocket No. 2 Open	Clearance Pocket No. 2 Closed	Outside Dry Bulb Temp.	Outside Wet Bulb Temp.	Relative Humidity	Air from Washer No. 1	Air from Washer No. 2	Republic office Dry Bulb Temp.	Wet Bulb Temp.	Relative Humidity	Heard Office Dry Bulb Temp.	Wet Bulb Temp.	Relative Humidity	East System Room No. 621 Dry Bulb Temp.	Wet Bulb Temp.	Relative Humidity	West System Room No. 621 Dry Bulb Temp.	Wet Bulb Temp.	Relative Humidity	REMARKS:
6 a. m.																																				
7 a. m.	75	82	152	79	180	40	56	54	53	47	47	47	600	615	✓		✓		90	69	34	55	55	80	71	64	80	68	54	80	68	54	80	67	50	
8 a. m.	75	82	152	80	180	39	54	52	51	46	46	46	600	615	✓		✓		92	69	30	53	53	79	69	60	79	67	53	80	67	50	79	66	50	
9 a. m.	75	82	152	80	180	39	54	52	52	46	46	46	600	620	✓		✓		93	72	36	53	53	79	68	57	80	67	50	80	67	50	79	66	50	
10 a. m.	75	82	152	80	180	39	54	52	52	46	46	46	600	620	✓		✓		94	74	38	53	53	79	67	53	79	67	53	80	66	47	79	66	50	
11 a. m.	75	82	152	80	180	39	54	52	52	46	46	46	600	620	✓		✓		96	75	37	52	53	80	67	50	80	67	50	80	66	47	80	66	47	
12 Noon	75	82	152	80	180	39	54	52	52	46	46	46	600	620	✓		✓		100	77	35	52	53	80	67	50	80	66	47	80	65	44	80	65	44	
1 p. m.	75	82	152	80	180	39	54	52	51	46	46	46	600	620	✓		✓		103	75	29	53	53	80	66	47	80	67	50	80	65	44	80	65	44	
2 p. m.	75	82	152	80	180	39	54	52	51	46	46	46	600	620	✓		✓		103	74	25	53	53	80	66	47	80	66	47	80	65	44	80	65	44	
3 p. m.	75	82	152	79	180	39	54	52	52	46	46	48	600	620	✓		✓		102	74	26	53	55	80	67	50	80	67	50	80	65	44	79	65	44	
4 p. m.	75	82	152	79	180	39	54	52	52	46	46	48	600	610	✓		✓		100	74	28	53	55	79	67	53	79	67	53	80	65	44	79	65	46	
5 p. m.	75	82	152	79	175	39	54	52	51	46	46	48	600	615	✓		✓		100	75	30	53	55	80	67	50	80	67	50	80	65	44	79	65	46	
6 p. m.																																				
7 p. m.																																				
8 p. m.																																				

Compressor On 6 A.M. On On On
Compressor Off 5 P.M. Off Off Off
Blower No. 1 On 5 30 A.M.
Off 5 P.M.
Blower No. 2 On 5 30 A.M.
Off 5 P.M.

METER READINGS
Today 49
Previous Day 24
Total 25 x 60 = K.W.H. 1500
Signed—Engineer D. P. Nonis

Fig. 2—One of the log sheets (for a typical day) which aid in operating the air-conditioning plant efficiently and yield information of interest to the owners. Outside temperatures as high as 103-F dry bulb and 77-F wet bulb are indicated on this sheet

The FLOW *of* FLUIDS *in* PIPES

A Study of the Data—Part I of a Series Which Will Include Fluid Friction of Compressible and Incompressible Fluids; Losses from Enlargements, Contractions and Fittings; Problems of Economical Design of Process Piping . . . . . By Emory Kemler*

IT was not until 1883, when Reynolds by dimensional analysis developed the equations for dimensional homogeneity and dynamic similarity, that any scientific basis for analyzing the experimental data on the flow of fluids was available. In view of the fact that only a small part of the experimental work on this subject has been reduced to Reynolds' dimensional basis, it was deemed desirable to undertake the investigation summarized in this article to get a more complete knowledge of the flow problem, and in it an attempt was made to obtain all the data available on flow in pipes under pressure.

Types of Fluid Flow

Reynolds found from his experiments on the flow of fluids that there are two types of fluid motion. These experiments were made by drawing clear water through a transparent tube and admitting a very small stream of colored fluid near the entrance to the tube. When the velocity was low the stream of colored fluid extended through the tube in a straight line without mixing with the water. As the velocity was increased it finally reached a value at which the colored stream would mix with the surrounding water and the tube would appear to be filled with a colored liquid.

The first of these types of flow is called streamline or viscous flow, and, as the motion of the fluid particles is definitely known, the problem of flow for this case can be treated mathematically. The second type is called turbulent or sinuous flow. In this type of flow, eddies are present, and, since the motion of the individual particles is not known, the problem of flow in this case must be studied experimentally. The principle of dimensional homogeneity offers the method of approach to the study of the turbulent-flow problem.

Dimensional Homogeneity

The principle of dimensional homogeneity states that in any complete physical equation all equal terms must have the same dimensions. It can be shown by this principle that, since only the diameter of the pipe, the velocity of flow, the density of the fluid, and the viscosity affect the loss of head per unit length, we can express the loss of head by

$$\Delta p = \rho \Delta h = \frac{f l v^2 \rho}{2gD} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

provided f, the friction factor, is a dimensionless quantity. Reynolds showed that for this to be true f must be some function of $Dv\rho/\mu$. The form of this function must be determined experimentally for turbulent flow. Hereinafter the term $Dv\rho/\mu$ will be called Reynolds' number and will be designated by R.

List of Symbols

D = Diameter in feet
v = velocity in feet per second
ρ = density in lb per cu ft
μ = absolute viscosity in ft-lb-sec units
l = length of pipe in feet
$g = 32.2$ = acceleration of gravity
f = friction factor
R = Reynolds' number
Δp = drop in pressure in lb per sq ft
Δh = loss of head in feet of liquid

The Critical Reynolds' Number

The value of Reynolds' number at which the type of flow changes from streamline to turbulent flow or vice versa, is called the critical Reynolds' number. This number is not well defined and may vary over a considerable range. In this unstable range of R the projected friction factor for streamline flow falls below the value for turbulent flow. Because of this fact, it is the minimum value of Reynolds' number at which turbulent flow can exist under normal conditions in which we are interested, since this value represents the maximum value of f that will be found in practice.

Hopf in the "Handbuch der Physik" gives a review of the work done on determining the value of the critical Reynolds' number and says that 2000 is a minimum value at which turbulence occurs under conditions similar to those met in practice. Streamline flow may continue at higher values, but turbulent flow cannot continue below this value except under the most favorable conditions. The various experimenters have found that under ordinary conditions the critical value varies from approximately 2000 to 3000. The region between these

*Engineering Division, Gulf Research Laboratory, and Instructor in Mechanical Engineering, University of Pittsburgh. The paper of which this article is an abstract was contributed by the Hydraulics Division for presentation at the Annual Meeting, New York, N. Y., Dec. 5 to 9, 1932, of *The American Society of Mechanical Engineers*, and will appear in complete form with discussions in the hydraulic section of the *A. S. M. E. Transactions*. Articles prepared exclusively for HEATING, PIPING AND AIR CONDITIONING by Mr. Kemler (to be published in future months) will show the application of the data in the present paper to industrial piping problems.

two values is an unstable one and the value of the friction factor depends upon how this region is approached.

Streamline Flow

As stated earlier, streamline flow can be treated mathematically. In this case the pressure drop results from the shearing stresses necessary to move the particles relative to each other, or it may be considered as being caused by the viscosity of the fluid. The equation for pressure drop can be derived on this basis and is given by

$$\Delta p = \frac{64\,\mu l v}{2\,gD^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

Equation 1 will also apply to viscous flow provided f is a function of R. It has been found for streamline flow that $f = 64/R$. Substituting this value for f in Equation 1, the result is the same as that given by Equation 2. The pressure drop for flow in straight pipes can then be calculated by Equation 2 provided R does not exceed 2000 and the pipe is circular in cross-section.

Analyses of Turbulent-Flow Data

Method of Analyzing Data:

In summarizing the data on *turbulent* flow for pipes, the original or published data were recalculated and analyzed on the basis of dimensional homogeneity. The data of each experimenter on a particular pipe size were recalculated and then plotted. An average curve for the particular pipe size was then selected. This average curve has been put on a summary drawing to serve as a permanent record and for the selection of a final average for a particular kind and size of pipe. Each curve on the summary drawings is marked with a letter and number. The letter refers to the experimenter (the letter used for each experimenter being given in the table of references), and the number to the inside diameter of the pipe in inches.

The fact that there is no slip at the boundary or surface of the pipe in either streamline or turbulent flow makes it seem reasonable that the friction factor at the absolute critical Reynolds' number should be independent of the pipe size. On this basis, at a Reynolds' number of 1160 the friction factor should be independent of the pipe size regardless of its roughness provided the diameter used is the one to make the friction curve coincide with the value $f = 64/R$ in the viscous region. This then gives one point for comparing the friction curve for various sizes of steel pipe as well as rough pipes.

Smooth Pipes:

The flow in smooth pipes offers a starting point for the study of the general turbulent-flow problem since they will have the lowest friction factor and will therefore determine the minimum value of friction factor obtainable. Smooth pipes are closely approximated by good commercial drawn brass pipe. Smooth lead, glass, and tin pipes also give results near those of brass pipe. Fortunately a considerable amount of experimental work has been done on this kind of pipe, so any conclusions that can be drawn will be well substantiated by experimental evidence. A few summaries have been made by other investigators of the work on smooth pipes, but none of these has taken all the data available for use in his analysis. In the following summary all the experimental data that have been published were reduced to the basis made available by Reynolds.

The tests on brass pipe analyzed numbers between 1500 and 2000 and represent pipe sizes from 0.107 in. to 5 in. in diameter, using air, water, and brine as fluids.

In analyzing the immense amount of data on brass pipe each individual series of tests by a particular experimenter on one size of pipe were recalculated and plotted, using f and R as the coordinates. It was found that the experiments gave values that agreed well and that the friction factor was independent of the pipe diameter for the pipe sizes tested for equal values of R. The results for the different fluids were also found to be in perfect agreement. Therefore with brass pipes the

Table 1—Summary of tests on new steel pipe, showing the experimenters whose investigations were studied and correlated

(Water is fluid used unless otherwise noted)

Experimenter	Range of sizes (diam, in.)	Source of data	Remarks
Freeman (F)	0.36–8	"Flow of Water in Pipes," by Mills	Pipes had screw-joint couplings
Darcy (D)	0.48-1.55	Do.	Diameters varied 18 per cent on small sizes
Smith (S)	0.627	Do., or "Hydraulics," by Smith	Joints made by butting ends of pipe
Omkeck (O)	0.78	"Handbuch der Physik," vol. 7, p. 150, or "Forschb. der V.D.I.," vols. 158 & 159, 1914	No data available
Francis (Fr)	0.801–2	"Flow of Water in Pipes," by Mills	Apparently the same as Smith's tests
Rowland (R)	1	"Flow of Water," by Schmeer	No joints
Poche (P)	1	*Power*, vol. 34 (1911), p. 34	Couplings used
Fritzsche (Fri)	1–1.54	"Handbuch der Physik," vol. 7, p. 150	No data available
Gould & Levy (G & L)	1.38	Univ. of Ill. Eng. Expt. Bul. No. 182	No couplings. Brine used
Brix (B)	3¼–6½	Phil. Trans., vol. 214	No data given on pipe. Air used
Corp & Ruble (C & R)	½–12	Univ. of Wis., Bul. No. 1, vol. IX, p. 39	Flanged joints
Brabbée (Br)	½–6	Gresecke in *Jl. A.S.H. & V.E.*, vol. 21, p. 478	Temp. varied widely, but values not given
Kite & Kennedy (K & K)	1, 2, 4	*Jl. Ind. & Eng. Chem.*, vol. 14, no. 2, p. 112	Data on individual sizes not given. Oil used
Bayles (Ba)	8.94	Scobey, "Flow of Water in Riveted Steel & Analogous Pipes"	Standard coupling-type joints
Glazebrook, Higgins & Pannell (GH & P)	3 & 4	*Jl. Inst. Pet. Tech.*, vol. 2 (1914–1915), p. 54	No couplings, 5 ft. gage length and accurate manometer used. Oil used
Lander (L)	0.422–1.3	Proc. Roy. Soc., vol. 92-A (1916), p. 337	Joints made by butting ends of pipe. Steam and water used
Greeve (Gr)	1½	Purdue Univ. Bul. No. 2, "Flow of Water through 1½-In. Pipe"	One coupling in 40-ft length
Corp & Hartwell (C & H)	1–4	Univ. of Wis. Bul. No. 66, p. 83	Probably no joints
Davis (Da)	2	Univ. of Wis. Bul. No. 403	Flanged joints used
Standard Oil Co. of Calif. (SO)	...	"Flow Book"	Data from oil-pipe-line tests. Oil used
Heltzel (H)	8–12	*Oil & Gas Jl.*	Data from pipe-line tests. Oil used
Feely & Riggle (F & R)	0.27	Univ. of Pittsburgh unpublished thesis	No couplings. Air and water used
Berwald & Johnson (B & J)	1–2	U. S. Bureau of Mines R.I. 3153	Air and natural gas used
Beale & Docksey (B & D)	0.3	*Jl. Inst. Pet. Tech.*, Aug., 1932	.....
Anglo Persian Oil Co. (APOC)	2–12	*Jl. Inst. Pet. Tech.*, Aug., 1932	Natural gas used
Fair, Whipple & Hsiao (F W & H)	1½	*Jl. N.E. Water Wks. Assn.*, vol. 44 (1930), pp. 499–513	.....

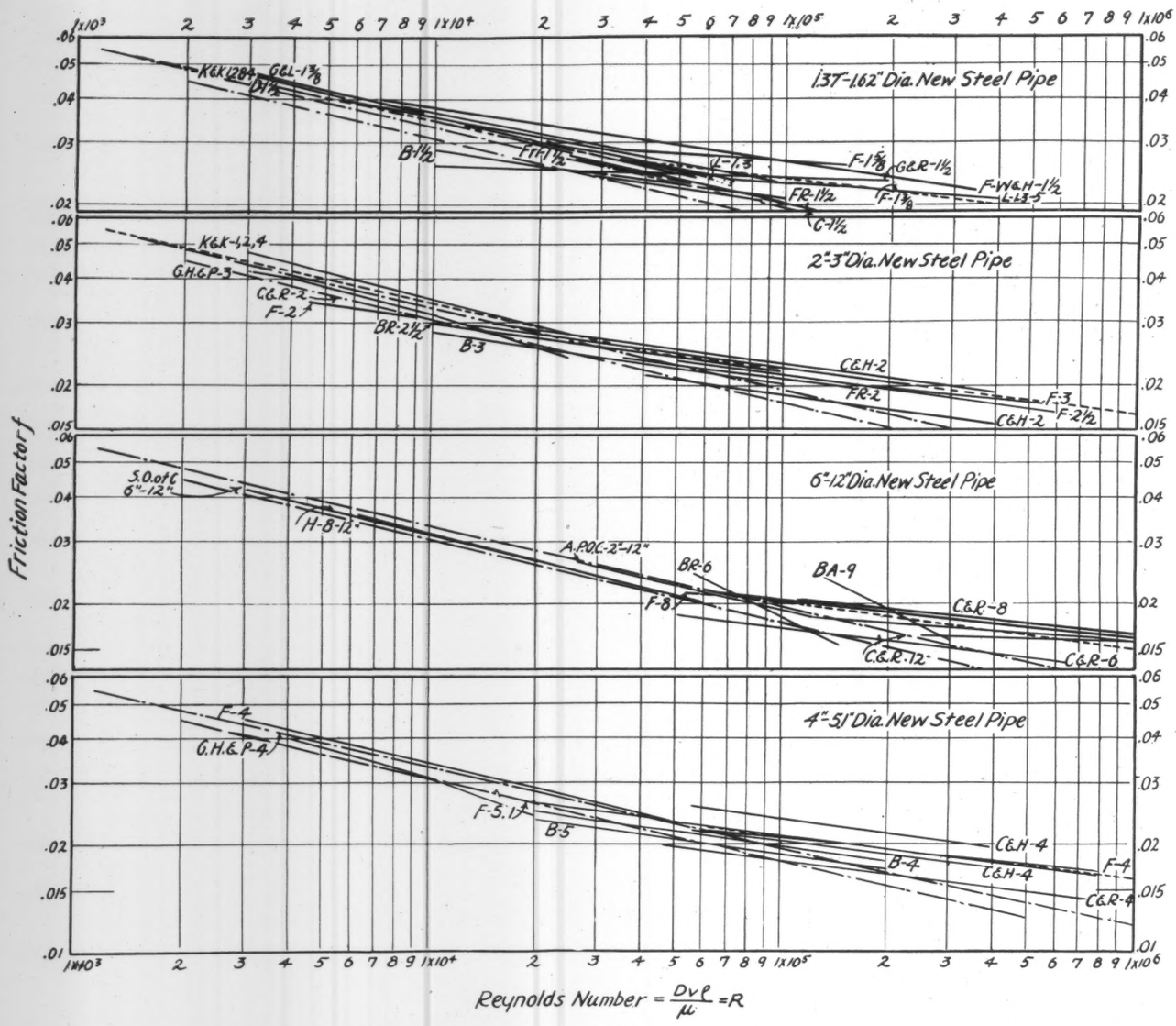

1.37-1.62" Dia. New Steel Pipe
2"-3" Dia. New Steel Pipe
6"-12" Dia. New Steel Pipe
4"-5.1" Dia. New Steel Pipe
Friction Factor f
Reynolds Number = Dvρ/μ = R

Fig. 1—Summary of tests on flow in new steel pipes

friction factor for a particular value of R can be used regardless of the pipe size and fluid flowing. In the analysis of the test data it was impossible to reproduce all of the data in one drawing since so many of the tests gave identical results, and it became necessary to study the problem by determining the boundary within which all of the data would fall. This boundary is shown by the two dot-dash lines in Figs. 1 and 2.

It was felt that even with relatively smooth pipes there would be a small variation in friction factor for each pipe because of slight variations in the pipe surface. By representing the friction factor as falling within a certain range, as was done in this case, the results would more nearly represent the actual conditions than by using a single average line. The lower curve represents a value of the friction factor about 10 per cent lower than the upper or maximum value. The range of friction factor for smooth pipes can be considered as varying by ± 5 per cent from an average curve. Considering the nature of turbulent flow and the variations in commercial pipe, this is rather consistent from an engineering standpoint.

New Steel Pipes:

The turbulent flow of fluids in steel pipes has never been subjected to a scientifically planned study because most investigators were unable to correlate the data for the various pipe sizes or their data with those of other investigators. In this analysis all of the data of independent investigators of which records were available have been compiled and studied. Curves are grouped on the basis of actual inside pipe diameter in inches, and not according to the conventional method of denoting pipe sizes. This permits the data to be applied to heavy and extra heavy pipe and tubing as well as to standard pipe.

The summarized results are surprisingly consistent in that extreme values do not in general vary more than ± 10 per cent from the average curve at higher values of Reynolds' numbers, and less at lower values of R. When it is considered that these data represent the experiments of 26 independent investigations made over a period of 80 years, the results are all the more remarkable. The most complete series of tests are those by Dr. John R. Freeman. His tests covered the entire range

of pipe sizes, and the results in each case are seen to fall very close to the average curve.

The oldest set of tests are those by Darcy, which were made in 1852. The ½-in. and 1-in. sizes show a friction factor higher than those in other tests on corresponding sizes. The description of the pipes states that the diameter varied as much as 18 per cent for these sizes, which accounts for their apparently high friction factor. His results on the 1½-in. size are consistent with other experimental results. The tests by Lander on steam and on water form a continuous curve and show that the flow of dry steam practically follows the dimensional law. The tests by Feely and Riggle on ⅛-in. standard black pipe also show the curve for water and air to be continuous. These tests were made on a pipe ordered from stock and show that this size of pipe is relatively very rough. A test using a heavy lubricating oil showed that the measured pipe size made the friction curve for low Reynolds' numbers follow the curve $f = 64/R$, which gives a better check on the diameter than measuring the volume by filling the pipe with water.

The summary curve gives the selected average values for the different sizes of new steel pipes. *The extreme values do not in general vary more than ± 10 per cent from the average at higher Reynolds' numbers.*

Conclusions

Some of the more important conclusions to be drawn from the foregoing data are:

1. The friction factor is independent of the fluid flowing for the same values of R.
2. The friction factor for drawn brass pipe varies only ± 5 per cent from an average value and is substantially independent of the pipe size and fluid flowing for the same value of R within the range encountered in practice.
3. The friction factor for new steel pipe varies with the size and varies about ± 10 per cent from an average value. The reason for the variation with size is because the relative roughness increases with decrease in diameter.
4. The data on used and artificially roughened pipes show that if the roughness is not large enough to cause contraction and enlargement losses, the friction factor never exceeds the value 0.054.
5. The mean hydraulic radius can be safely used as a criterion only in the turbulent region.
6. Special care should be taken in the selection or determination of the diameter.

Of these conclusions, the most important one is that

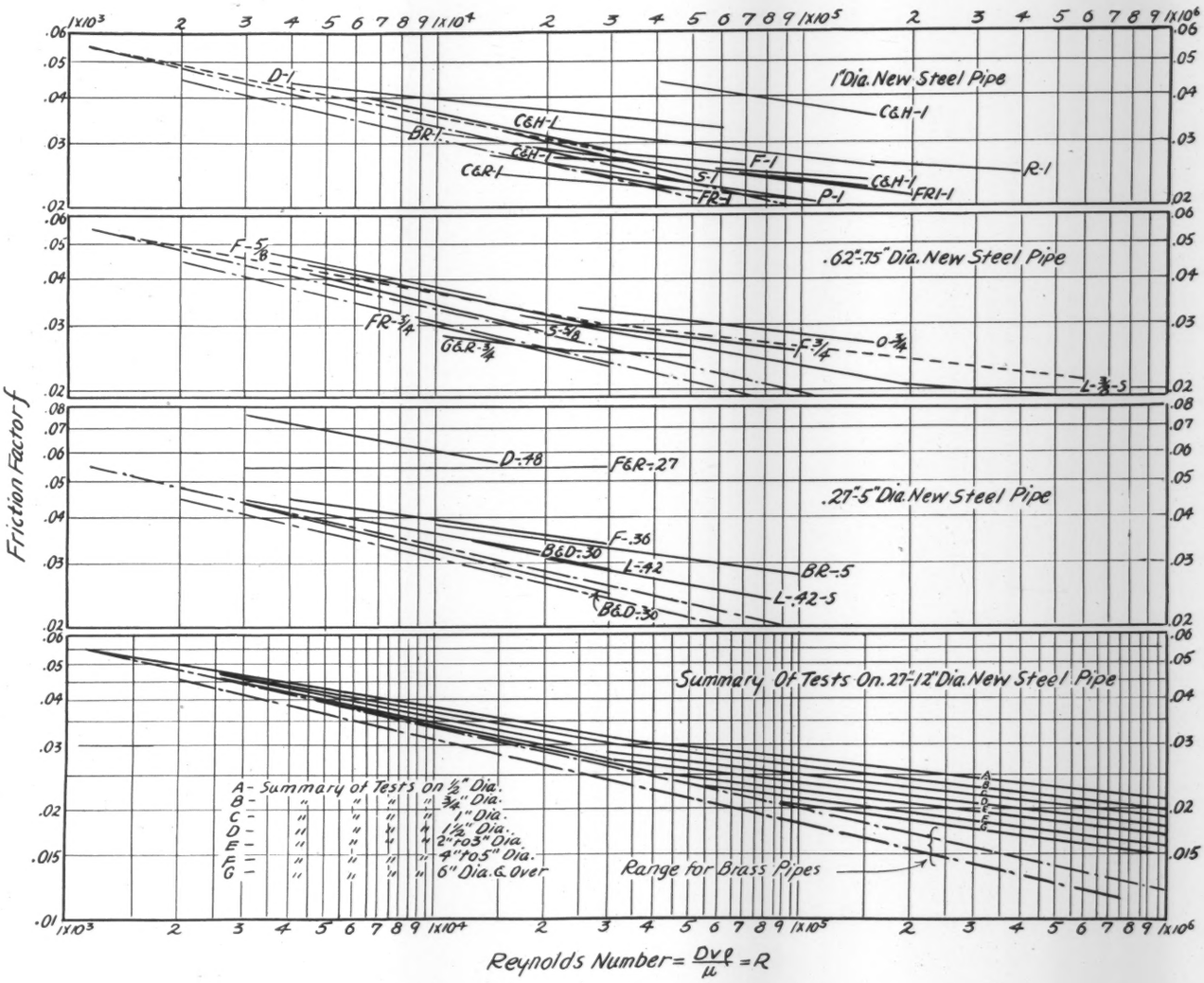

1"Dia. New Steel Pipe
.62"-.75" Dia. New Steel Pipe
.27"-.5" Dia. New Steel Pipe
Summary Of Tests On .27"-.12" Dia. New Steel Pipe
A- Summary of Tests on ½" Dia.
B- " " " ¾" Dia.
C- " " " 1" Dia.
D- " " " 1½" Dia.
E- " " " 2" to 3" Dia.
F- " " " 4" to 5" Dia.
G- " " " 6" Dia. & Over
Range for Brass Pipes
Friction Factor-f
Reynolds Number = Dvρ/μ = R

Fig. 2—Summary of tests on flow in new steel pipes

there is an upper limit for the friction factor. While this upper limit has not been proved conclusively, the data show that unless the roughness becomes of such an order of magnitude as to cause effects such as occur when there are contractions and enlargements, the friction factor will not become greater than 0.054. The limits of roughness are yet to be determined and will probably have to be ascertained by taking velocity traverses along as well as across the pipe.

The upper and lower limits of the friction factor having been determined, the next problem is the selection of values for various types and sizes of pipes. This problem has been discussed by R. J. S. Pigott in a recent paper. His curves for the various types and sizes of pipe are the best and most extensive that have been proposed for design work and should be considered in connection with the present paper.

The effect of diameter on flow is worthy of further mention. It has been seen that $v = V/A = 4V/\pi d^2$, so that

$$\Delta h = \frac{8flV^2}{g\pi^2 D^5} \text{ or } f = \frac{\Delta h g \pi^2 D^5}{8lV^2}$$

From this it can be seen that a small change in D would produce a very large change in f. Since all quantities in the equation for Δh are fixed except D, the value of f will vary inversely as D^5. If, for example, in the design of a pipe line the value of f is selected and a value of $D = 1$ is used while the actual value of $D = 0.9$, the calculated Δh would be $8fV^2/g\pi^2$, whereas the actual Δh would be $1.7 \times 8fV^2/g\pi^2$. The pressure drop would actually be 70 per cent greater than the value based on $D = 1$. Experimental results would show f 70 per cent higher than was actually the case. For design purposes where incrustations are expected it is much safer to estimate the ultimate diameter and use $f = 0.054$ than to estimate the ultimate value of f.

Engineering as a Career

"Engineering—A Career, A Culture" is the title of a 64-page booklet which has been published by the education research committee of The Engineering Foundation, New York City. Addressed to young men and to parents and teachers, the pamphlet is intended to clarify the broad field of engineering.

A chapter is devoted to each major field of engineering, and each is described from a professional standpoint. The opportunities in engineering are described generally and the personal qualifications which are required are outlined.

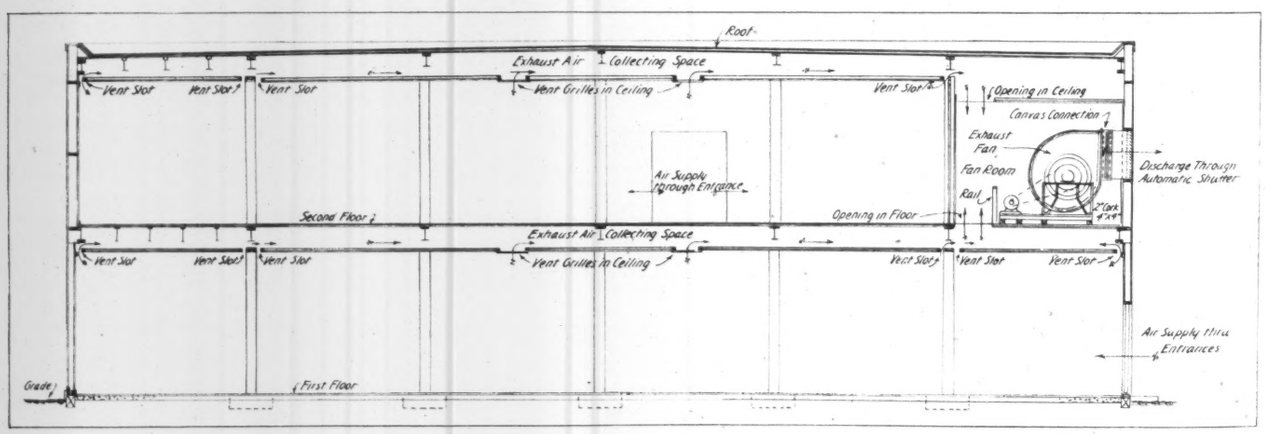
Large Air Volume Exhausted from "A Century of Progress" Buildings

BY exhausting an exceptionally large amount of air, the exhibition buildings of A Century of Progress (Chicago World's Fair) will be kept cool and comfortable. In line with the policies governing the construction of the Fair, economy in construction and low cost of operation were the objects sought in the design of the ventilating systems.

Approximately 4 cfm of air for each square foot of floor space are exhausted. As shown in the diagram the arrangement consists of utilizing the space between the suspended ceiling and the floor deck above as a plenum chamber. Air is drawn through grilles and slots above the exhibition booths into this chamber and discharged to the atmosphere. An idea of the size of this ventilating job is given by the fact that from one building—the Hall of Science—1,200,000 cfm will be exhausted.

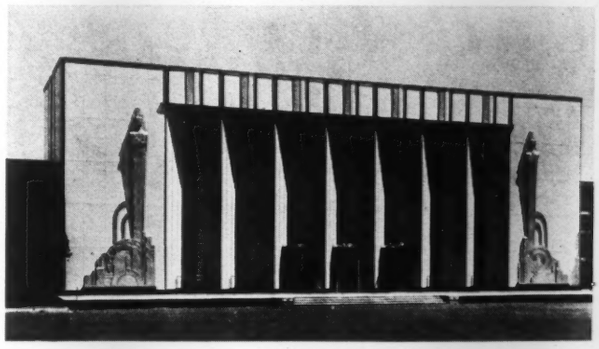
In general, the exposition buildings are windowless and one, two or three stories in height. Each floor level

Typical exhaust ventilating system for A Century of Progress buildings. Four cfm per sq ft of floor area are pulled from the structures

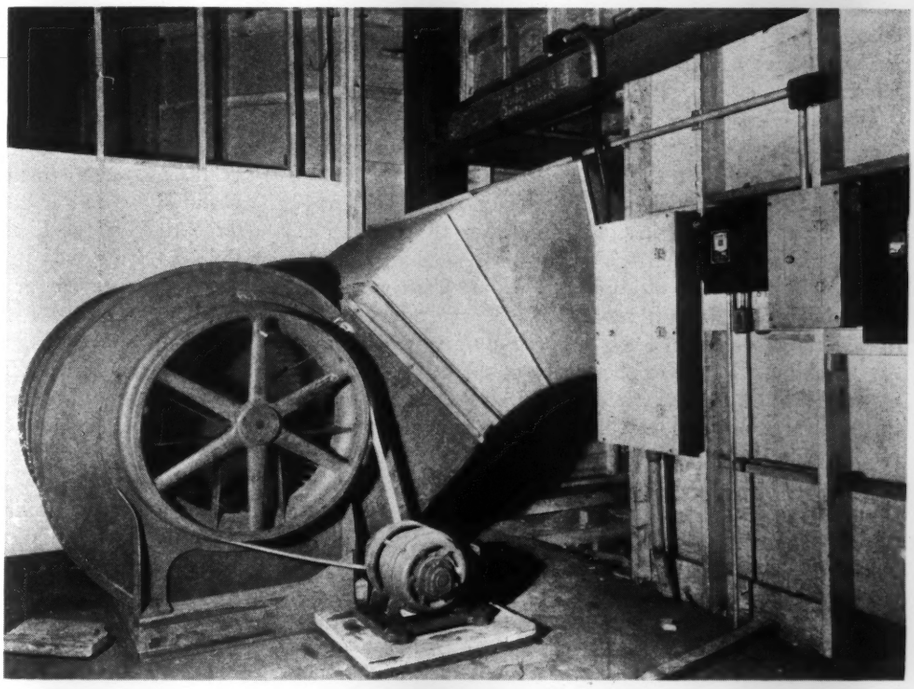


is independently connected to fans and fire stops separate the construction at each floor level. Both propeller-type and centrifugal-type fans are used, the former direct-connected and the latter with belt drive. Sound isolation bases of cork are provided; duct construction was kept to a minimum as the length of duct required from the plenum space to the fans and from the fans to the exterior-wall louvers is short.

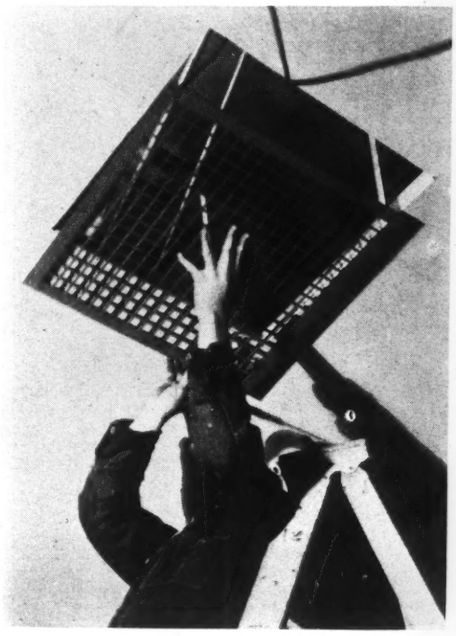
The Fair is scheduled to be opened formally on June 1; because of the many engineering meetings planned for Chicago this summer it will attract numerous visitors interested in the construction and equipment of the buildings themselves, as well as the exhibits. J. L. McConnell, from whom the above information was obtained, is chief mechanical engineer for A Century of Progress.



Main facade of the Administration Building of Chicago's 1933 Century of Progress exposition. The building is 350 by 150 ft, of modern design, located on sloping, filled-in land. On the lake side, three wings are stepped down in terraces to the water's edge. It is heated by a gas-fired vacuum steam system, as it has been occupied for some two years

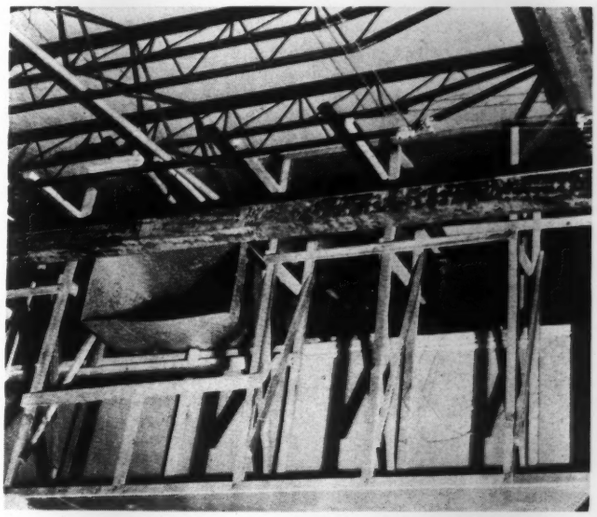


At right—A typical fan room, showing the short duct connection to atmosphere and sound isolation of the motor



At left—Opening in ceiling, through which air is drawn from the building to the plenum space and then exhausted

Below—Vent from a transformer vault



Unit Heaters Answer Many a Process Problem

. . . . By Laurin J. Zorn, *based on information from* Kimball Burr*

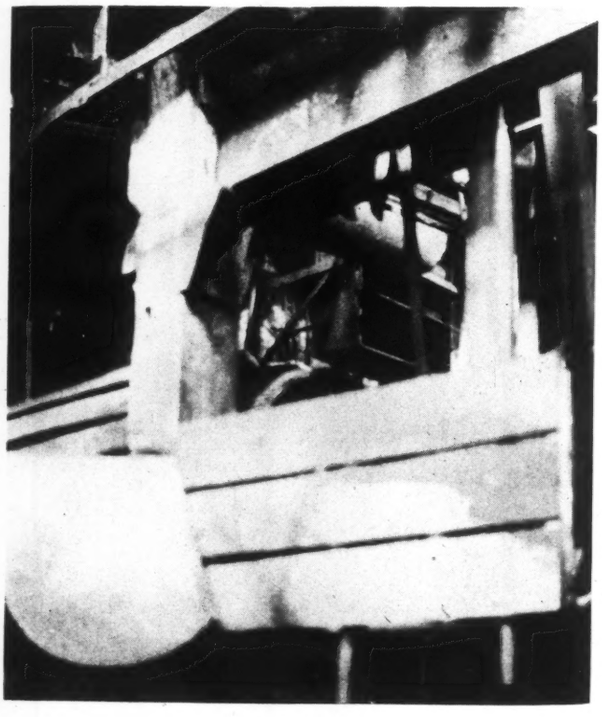
MANY interesting applications outside the field of space heating have been discovered for the unit heater. The packing-plant applications described here are suggestive of other uses that may solve similar problems.

Great difficulty has often been experienced with excess humidity in connection with the slaughtering and dressing process. In the plant of the Agar Packing and Provision Co., Chicago, a heavy steam vapor constantly arose from the hog dehairing machine to obscure the vision of the workmen. The hog is placed in the machine right from the scalding vat. The steam was dissipated by placing a unit heater in the near upper corner of the room so as to direct a current of warm air over the machine. It solves the problem effectively and the men working over the machine have no difficulty watching the carcass being worked. While warm air is supplied by the heater during the cold months, serving the purpose of warming the room and dissipating steam simultaneously, in summer months the unit serves as a cooler, cold water being circulated through the coils.

Excess humidity in various hot vat and tank rooms causes moisture to condense on the walls and ceiling of the room, seriously impeding work, and resulting in most unsatisfactory working conditions. To solve the problem unit heaters have been installed with a short duct connection to the outside and with provisions in the duct construction for partial or 100 per cent recirculation. The moisture-laden room air is carried through the unit, heated, and the moisture evaporated. The admission of outside air keeps the room from being overheated, provides ventilation, and regulates the dewpoint in the room. One unit heater installed in a highly humid branding room completely overcame the troublesome problem of running brands.

In another case a unit heater was used in connection with a smoke house. In this case gas was used as the medium of heat and the fuel cost was high. Prior to the installation of the unit heaters the smoking process was a lengthy one. The meat had to be arranged by hand on the cages before being introduced into the smoke house to insure even smoking, and when the meat was finally removed from the smoke house it was necessary to color it artificially. Artificial coloring of meat is an expensive and unsatisfactory practice inasmuch as every piece of meat so colored must by law be stamped or marked "artificially colored." The dyes used are of vegetable origin and are expensive.

Unit heaters were installed in this smoke house directly connected to the high-pressure steam line with the result that the gas cost was entirely eliminated with the exception of the gas used to ignite the sawdust. Artificial coloring was found to be no longer necessary, and the time required for the smoking process was materially reduced. It was found unnecessary to prearrange the meat on the cages, resulting in reduced handling and labor costs. In addition to this, the quality and flavor of the meat was greatly improved due to the forced circulation of the smoke by means of the unit heater fans. Temperatures in the smoke house were easily and accurately controlled by means of simple thermostatic devices, an impossibility with the open gas flame. The cost of this installation was negative in comparison with the benefits derived.



Unit heaters have many applications outside the field of strictly space heating. This one—in a packing plant—was installed to dispel the vapors rising from a hog dehairing machine to improve the working conditions

*Western Division, B. F. Sturtevant Company, Chicago, Ill.

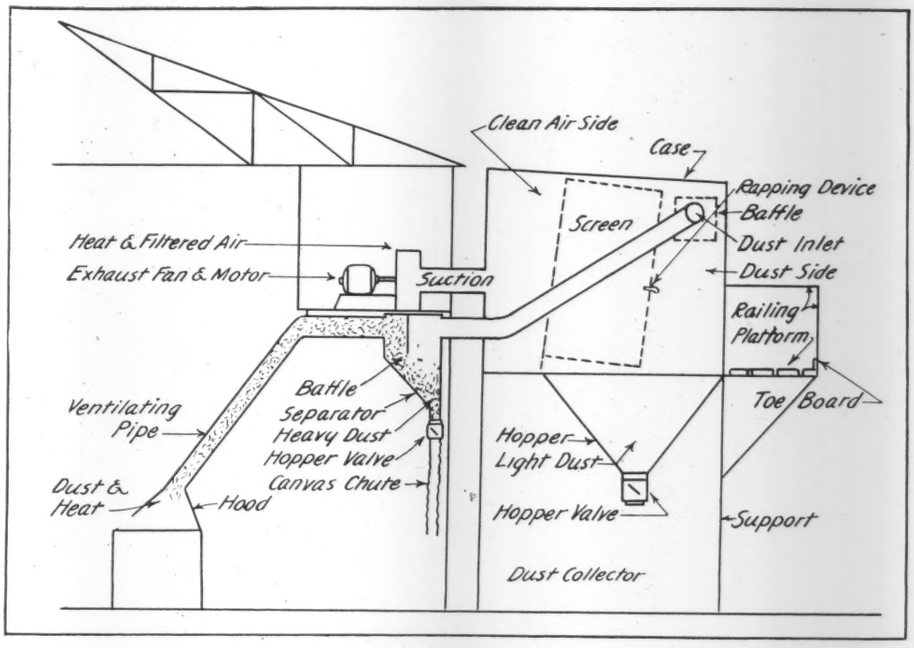


Fig. 1—Layout of a typical industrial cloth-screen-type dust collection system consisting of the exhaust hood and piping, the dust collector proper, and the exhaust fan. Such a system improves plant working conditions and production, recovers valuable dusts, and aids fuel economy if the filtered air can be recirculated

Operation, Maintenance of Cloth-Screen Dust Collectors

Recent years find increased attention given dust collection through pure air activities, litigation involving dust hazards, possibilities of recovery of valuable dusts and opportunities for fuel saving by cleaning air and recirculating it. In this article the author (who has had a wide field experience) describes a dust-collection system of the cloth-screen type and outlines the requirements for maintenance and operation so that results will be satisfactory and economical.

By W. F. Terry*

CLOTH-SCREEN-TYPE dust arresters are used to collect and confine industrial dusts, and to recirculate the filtered exhaust air into a factory. In this article the operation of such a system is described in detail; the maintenance difficulties caused by leaks, dirty screens, and neglecting to empty hoppers are explained; the layout of the piping and the proper care of the fans and motors are discussed. A method for controlling screen rapping by the pressure drop through the arrester is also proposed.

Dust Collection Improves Working Conditions, Recovers Valuable Dust, Saves Fuel

The primary reason for installing efficient cloth-screen collectors may be hygienic but often it is found that production is increased as the result of better working conditions. Frequently the plant finds a market for the collected dust and even may recover valuable material formerly wasted. In many cases it pays to recirculate the cleaned air into the plant; a fuel saving as high as 1½ tons of coal per month per 5000 cfm of air discharged is within the author's personal experience.

* Department of Industrial Hygiene, Harvard School of Public Health, Boston, Mass. Formerly Field Inspector, Plant Engineering Department, General Electric Company.

Operation of a Dust-Collection System

In its simplest form the dust arrester is an air-tight metal case in which are placed the screens, consisting of wooden frames reinforced by wires upon which cloth is stretched, as shown in Fig. 1. In place of screens, tubular cloth bags supported at both ends may be used. In either system the screens divide the arrester into two parts known as the *dust* and *clean-air* sections.

The dust section is connected by piping to the point where dust is generated. The clean-air section is connected to the exhaust fan. Cleaning the screens is accomplished by a rapping device which may be operated mechanically, electrically, pneumatically, or by hand. A suitable hopper for the collection and retention of the dust is provided with a discharge valve or gate.

Air containing dust particles is drawn into suitable

hoods located as near as possible to the points of dust generation. From the hood this dust is conveyed at a velocity of about 4000 fpm to the dust section of the arrester, where the velocity drops to about 1400 fpm, permitting the larger particles of dust to settle to the bottom and into the hopper. The finer particles are brought into contact with the filtering medium, or screens, on which they are caught and retained. The air continues through the screens to the clean-air section of the collector, then through the fan, and is discharged to the outside atmosphere or returned to the building to conserve heat.

The fan is placed on the suction side of both the cyclone and dust arrester. This location protects it from the abrasive action of the dusts which otherwise would rapidly wear out the fan blades and housing. If there are no air leaks in the piping, the power consumption of the fan motor is the same as if the fan were located ahead of the arrester.

Traps or Separators Grade Valuable Dusts

Valuable dusts may be recovered and graded pneumatically by traps or separators placed in the main suction line. These operate on the same principle as the arrester, but steel baffle plates are substituted for cloth screens and serve to change the direction of air flow causing the heavy dust particles to drop out.

Maintenance Must Not Be Neglected

Assuming that the proper collecting system has been installed, tested, and the requirements of the particular problem fulfilled, it is strange—but true—that many executives then expect the plant to function perfectly with no further attention or, at best, they assign an inadequately-instructed workman to attend to it. The result frequently is that the dust-collection plan becomes inefficient, expensive, repairs are required, and the entire system may be condemned.

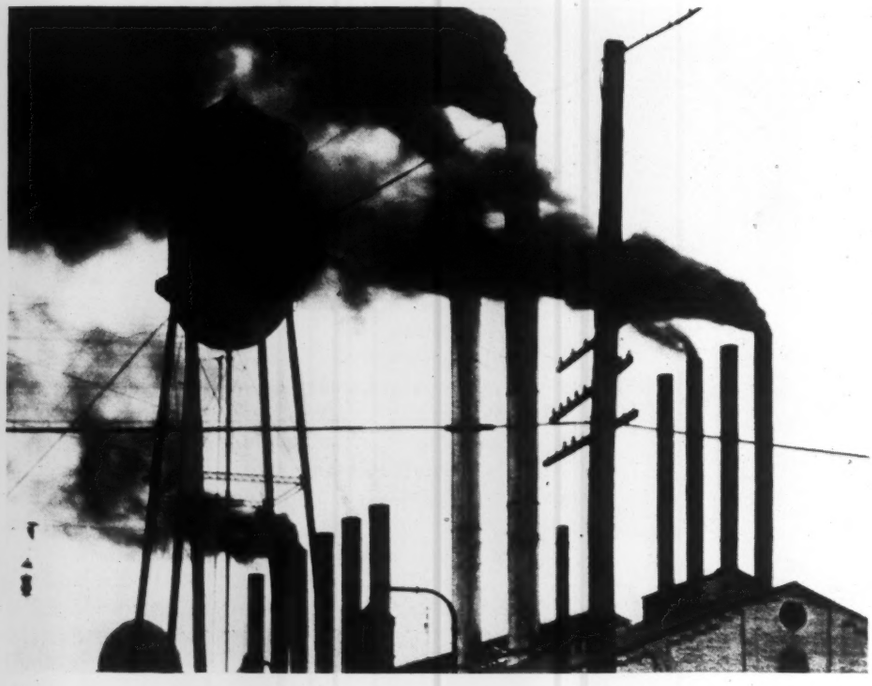
The major troubles experienced in a dust-collecting system of this type are due primarily to neglect to clean screens when necessary, neglect to empty hoppers when required, or from water, air, and dust leaks.

Cleaning the Screens

Screens must be kept reasonably clean at all times. A collector is designed to handle a definite volume of air to maintain the necessary suction to draw dust into the exhaust hood. As this dust-laden air must be filtered quickly, the filtering or screen area must be large enough to allow not only the air to pass through the cloth without unduly increasing resistance, but also to allow for the additional resistance caused by the building up of layers of dust on the filter surface.

After a collector has been in operation an hour or so, the screens become covered with dust and resistance increases in proportion to the thickness of the dust layer, producing two results, (1) the velocity of the dusty air entering the hood drops to a point where dust collection is inefficient, and (2) the dust inside the collector is forced into the fibers of the cloth screens; the cloth soon stretches to the point where the finer particles of dust are able to pass through. This stretching in time wears out the screens and replacement becomes necessary.

Screens should never be rapped while they are under suction; this prevents the coarser particles from falling into the hoppers below, and fine particles are pulled into the cloths. The system then loses its efficiency since the cloth, already pulled tightly on wooden frames or hoops spaced about one inch apart, is stretched still further and adjacent cloth surfaces flap loosely against each other, thus sealing off air flow at these points of contact. The remainder of the cloth must then do extra work, which has the cumulative effect of spoiling all the screens in a short time.



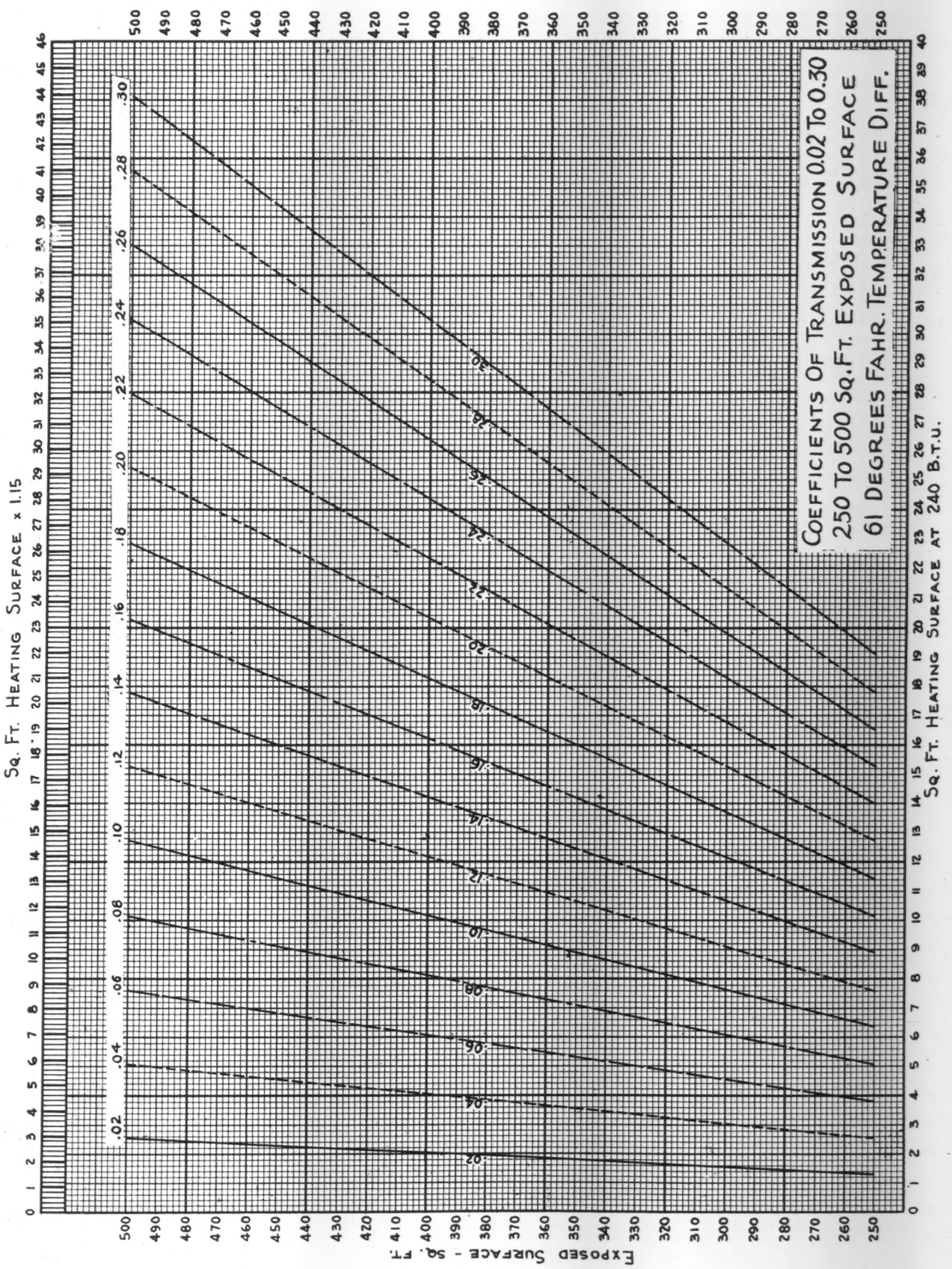
Rapping to Clean the Screens

In most installations the cleaning of screens is accomplished by some agitating mechanism such as a rapper or vibrator mechanically connected to a source of power. Someone should be delegated to operate this rapping de-

(*To page 71, back Advertising Section*)

Calculating Heating Surface for Buildings 2

.....by Price L. Rogers, Consulting Engineer, Philadelphia, Pa. This is Chart No. 2 of a series designed to enable computations for heat losses from buildings to be made accurately, with a minimum of time and with decreased possibility of errors. Chart No. 1 and an explanation of the series and its use was published last month.


Coefficients Of Transmission 0.02 To 0.30
250 To 500 Sq. Ft. Exposed Surface
61 Degrees Fahr. Temperature Diff.
Sq. Ft. Heating Surface x 1.15
Sq. Ft. Heating Surface at 240 B.T.U.
Exposed Surface - Sq. Ft.

INTERESTING Equipment..... Developments

New Heating Surface

The Griscom-Russell Company, New York City, has announced a new indirect heating surface with bent, finned tubes for use in heating and ventilating, air-conditioning and cooling systems.

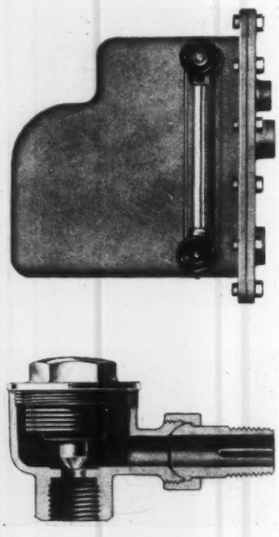
This apparatus employs tubing which has been extensively used for many years in a wide variety of heat-transfer apparatus and systems. The fins composing the extended surface of this tubing are attached by a mechanical process which provides a continuous metallic contact between fins and tubes, without requiring the use of solder or tinning. The construction is therefore suitable for high temperatures, and is adapted to practically any kind of material for special requirements.

An additional feature of this heat-transfer surface is the use of initially bowed tubes which accentuate their curvature on increase of temperature. Each tube is free to expand and change its curvature independently of all other tubes without binding or interference.

These units are light in weight, and are furnished complete and self-contained in a range of sizes and lengths. Distributors are Hitchen Engineering Co., Inc., 155 East 44th Street, New York City.

Boiler Return Trap; Radiator Trap

In addition to its differential loop and its line of pumps, the Hoffman Specialty Company, Waterbury, Conn., has announced a third device for the return of condensate to the boiler. This is the new boiler return trap, designed for use with vapor- vacuum systems fired with oil, gas or soft coal where pressures are generally built up quickly. It is also for use on installations where unit heaters or other devices require a constant pressure of more than 8 ounces.



At low pressure, water returns to the boiler by gravity, but when the pressure exceeds this point, the boiler return trap functions to return condensate promptly to the boiler. A feature of the trap is its balanced, double seated valve mechanisms controlling the steam supply and exhaust ports. They permit the use of light weights to promote quiet operation. Large port areas are also obtained for rapid equalization of pressure when the steam valve opens. All seating surfaces and working parts are made of non-corrosive metals and are enclosed entirely within the trap.

The receiver vent provides storage capacity for the condensate accumulating while the trap discharges to boiler and prevents temporary flooding of the end of the return. Air is vented through a valve on the receiver vent, which closes against its return to the system, allowing operation under partial vacuums.

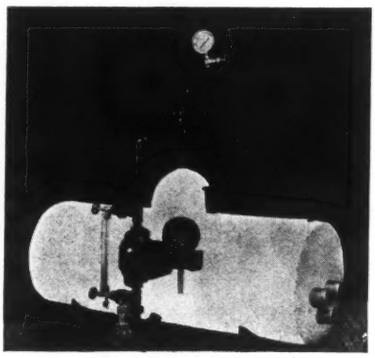
These traps and receiver vents are made in four standard sizes.

Also recently introduced by this company is a new radiator return trap. Among its features are a bellows-type thermostat which is hydraulically formed and tested in the making under 500 lb internal pressure. With this process, the folds of the bellows maintain a uniform metal thickness unimpaired by tool marks.

The thermostat is attached to the cap and can be interchanged without adjustment in any valve body. Trap specifications are: ½-in. connections, angle and swivel patterns. Nominal capacity for pressures under 1 lb, 200 sq ft of radiation. Port ⅜-in. Maximum guaranteed operating pressure, 15 lb. Bellows 1½-in. diameter, 6 convolutions.

Generate Process Steam

A new electric steam generator manufactured by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., supplies high- or low-pressure steam where steam is wanted



in limited quantities for process work and in large plants where it is not economic to run steam lines.

A complete line of generators with ratings ranging from 2 to 240 kw and two different pressure ratings (100 and 200 lb) are made. A quantity of steam may be flashed without reducing the normal pressure with the aid of an accumulator or flash capacity.

This flash capacity is obtained by raising a large volume of steam to a higher pressure than normal requirements and providing a pressure reducer. Where steam demands are large for the initial heating of platens, kettles, etc., this arrangement is useful. These generators are useful for the following applications:

Acid Heating—Where corrosion prohibits use of electric elements.

Conditioning Heating—In cotton, silk and leather mills to condition the product.

Auto Cleaning—Flash boiler supplies steam quickly with low standby losses.

Textile Slashers—Eliminates large-capacity boilers in electrified mills.

Isolated Heating—For building or processes located away from the main steam supply.

Plating and Pickling—Requiring a small yet dependable amount of steam the year-around.

Celluloid Tables—Low year-around cost for manufacture of celluloid articles.

Impregnating Tanks—Where impractical to increase heating capacity by electric-immersion elements.

Temporary Uses—Portable boiler for thawing out pipes or supplying unusual heat demands.

Laboratory Processes—Flexible and exacting steam supply for chemical retorts.

Tailor Machines—For pressing and blocking.

Night Building Heating—Using low-cost off-peak power. No attendant required.

Dairy Plants—Hot water and steam for washing and sterilizing.

Hydro-Electric Plants—Supply standby steam for peak-load plants, during idle periods, at low cost.

Home Heating—Large homes can use economically in Fall and Spring.

New Line of Pipe Vises

The Toledo Pipe Threading Machine Co., Toledo, Ohio, has announced a new line of open side pipe vises made in three sizes—No. 00, capacity ⅛ to 1½ in. pipe inclusive; No. 0, capacity ⅛ to 2½ in. pipe inclusive; and the No. 3, capacity ⅛ to 4½ in. pipe inclusive.

They have a heavy frame and long full over-lapping vise jaws. The jaws are made from tool steel, properly hardened, and when they become dull may be replaced. The handles are over-size and extra long to permit easy setting of the jaws and high leverage.

These vises are particularly applicable for fitting make-up work, says the manufacturer, as the jaw construction permits working close to the face of the vise, and will hold copper as well as iron or steel pipe.

A Sound-Isolating Motor Base

A new motor base with sound-isolating features has been developed by the General Electric Company, Schenectady, N. Y., after a study on the part of its research laboratory. Floating members are suspended on specially developed isolating material, enclosed and mounted for long life and protection. The motor is mounted as on a standard sliding base, and belt tension and motor alignment are maintained in the ordinary manner.

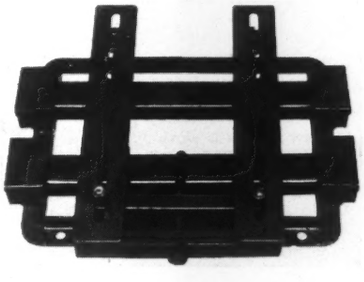
In addition to its sound-isolating qualities, the new base has the following features.

Adjusting screw moves motor for belt adjustment.

Bases are installed as a unit. No more attention to adjustment is required than is necessary for standard sliding bases.

The stiffness of the sound-isolating material is sufficient to maintain motor alignment for any reasonable belt tension.

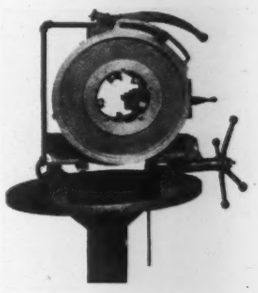
Guide washers in machine grooves are used with the belt-adjusting feature to maintain motor alignment.



These sound-isolating bases are designed for use with each particular motor for which they are recommended. They are equally effective at any motor speed between 100 per cent and 66 per cent of normal, and, in some cases, they are effective down to 50 per cent of normal speed. The bases are available for the following motor ratings and speeds: Polyphase induction motors of: 1 to 50 hp, 900 rpm; ¾ to 30 hp, 1200 rpm; 1 to 3 hp, 1800 rpm.

Single-phase motors of: ½ to 2 hp, 900 rpm; ½ to 2 hp, 1200 rpm; 1 to 5 hp, 1800 rpm.

New Die-Head for Old Machines



Oster-Williams, Cleveland, Ohio, has recently brought out a new die-head which can be installed on old pipe machines. The range of the new head covers all sizes of pipe from 1 to 6 in. and bolts from ¾ to 6 in. The head is calibrated regularly for Briggs Standard but can be marked special to suit requirements. A micrometer adjustment for over- or under-size threads is standard equipment.

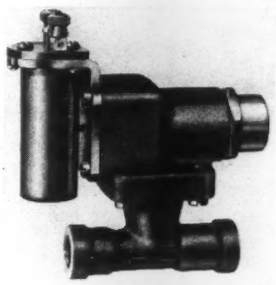
The threading dies are of high-speed steel, 5 to a set and are of the small segmental type, mounted in holders. Single segments are replaceable. For pipe work one set of dies threads all sizes from 1 to 2 in. and one set from 2½ to 6 in.

The die-holders are of hardened and ground steel. Dies are held in the holders by special socket, holding screw. The holders are moved "in" or "out" for various sizes by the leaf and slot method. The size setting and locking method is simple and positive. Cutting oil is pumped through the head to the threading dies.

The head is equipped with single high-speed cutting blade mounted on a gibbed slide, screw operated. The pipe is supported by a three-jaw, universal centering guide when being cut-off. The centering guide is bar-operated and self-locking. The reaming and chamfering of pipe is accomplished in one operation by means of a special forming tool mounted on the cut-off slide.

For use on jobs where long tapered threads are required, such as in oil field work, the head can be adapted to cut threads up to 4 in. long by means of special dies and holders.

Electric Valve for Humidity Work



An electric water valve developed primarily for humidity work but having a number of uses for air, gas, oil, steam and refrigerants which are not corrosive to brass has been developed by the Detroit Lubricator Company, Detroit, Mich. It operates through the making or breaking of an electric circuit, either by a humidostat, thermostat, or a control switch for temperature, pressure, or vacuum.

A feature is that it develops "power" when opening which allows the use of a heavy spring to close the valve, permitting tight closing of the valve against dirt, scale, etc. However, the valves—particularly when used on water—should be protected by a strainer.

This valve is rated at 16 volts, and when subjected to this voltage will draw 6 watts; no current consumption when closed. The valve is not damaged when on continuous service up to 24 volts.

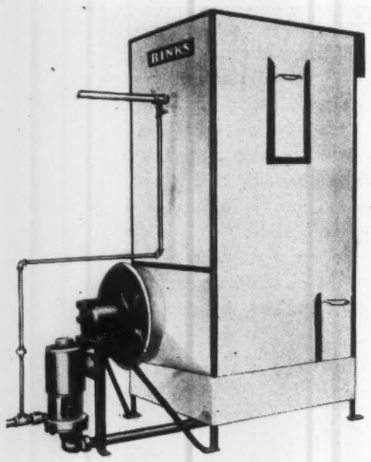
Regularly furnished with a 3/32-in. orifice to open against 100 lb maximum pressure, larger orifices can be furnished on special order. Inlet and outlet connections are 1/4-in. I. P. T.

Compact Heavy-Duty Switches

Although designed for severe duty, the safety switches of the type illustrated here and recently announced by The Electric Controller & Mfg. Co., 2696 E. 79th St., Cleveland, Ohio, are of compact construction. Nothing projects beyond the width of the box and the cover swings vertically, permitting mounting adjacent to pipes, etc. Boxes are finished carefully for good appearance and are 9 in. wide, 17½ in. long by 4 in. deep (230-volt, 60 amp. size); the 100-amp. switch is 3½ in. longer.

Features of the switches include semi-floating, double-break, V-blades, V stationary contacts backed up with steel springs, individual barriers (easily replaced) of arc-resisting asbestos—all mounted on a single base which can be removed when desired by taking out four screws.

Cooling Tower Requires Small Space

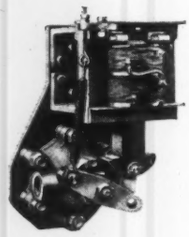


The Binks Manufacturing Company, 3114 Carroll Ave., Chicago, has recently made available a forced-draft spray cooling tower of compact construction for indoor installation which is adapted to a number of industrial and commercial refrigeration problems and heat-exchange work. Capacities range from 5 to 50 gpm, and a selection table specifies the proper size for refrigeration machines up to 1½ tons to 12 tons, diesel and gas engines up to 20 hp to 125 hp, and air compressors up to 125 cu ft to 1200 cu ft.

Especially recommended for use in congested districts and in buildings of more than average height, its principal feature is saving in water costs.

The tower is supplied with or without the water-circulating pump, as desired.

New Solenoid-Operated Valves



A line of solenoid-operated valves made in two-, three-, and four-way types has been made available by W. H. Nicholson & Company, 144 Oregon St., Wilkes-Barre, Pa. The valves are recommended where it is desired to operate single- or double-acting cylinders by remote control through a push-button station or an automatic time-cycle device.

Embodied in the unit is a flat disc, regrinding type of valve made of metals designed to hold tight and operate easily over a long period. It has a large-size stuffing box in addition to a bevelled shoulder on the stem seating against the body, giving two seals to provide double insurance against leaks.

The valves are available for operation on 110, 220, 440, or 550 volts, both a-c and d-c.

Conventions and Expositions

National Warm Air Heating Association: Mid-year convention, June 6-8, Hotel Stevens, Chicago. Managing director, Allen W. Williams, A. I. U. Building, Columbus, Ohio.

American Oil Burner Association: Annual convention, June 12-16, Hotel Stevens, Chicago, Ill. Secretary, H. F. Tapp, 342 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers: Semi-annual meeting, June 22-24, Hotel Statler, Detroit, Mich. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society for Testing Materials: Annual meeting, June 26-30, Hotel Stevens, Chicago. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

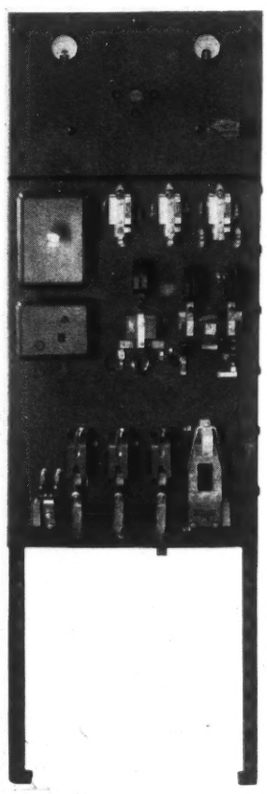
Midwest Engineering and Power Exposition: June 25-30, Coliseum, Chicago. Headquarters, 308 W. Washington St., Chicago.

National District Heating Association: Annual convention, June 26-28, Hotel Sherman, Chicago. Secretary, D. L. Gaskill, 603 Broadway, Greenville, Ohio.

Heating and Piping Contractors National Association: Annual convention, July 25-28, Chicago. Secretary, J. C. Fitts, 50 Union Square, New York City.

American Gas Association: Annual convention, September 25-29, Chicago. Headquarters Office, 420 Lexington Ave., New York City.

Synchronous-Motor Controllers



All standard lines of General Electric synchronous motor control have been superseded by new lines incorporating several features. Included in this control equipment are relays for automatically applying and removing field excitation and for protecting the stator and amortisseur windings under all operating conditions.

For automatically applying field excitation when the motor reaches a predetermined speed near synchronism, a new relay known as the slip-frequency field - application relay is provided. The coil of this relay is connected across a section of the field discharge resistor with a half-wave copper oxide rectifier in series with it. During the starting period, induced field current of slip-frequency flows through the discharge resistor so that half-waves of slip-frequency current flow through the relay coil causing the relay to pick up and open

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Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

MAY 1933

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The Heat Output of Concealed Radiators

By E. A. Allcut† *(NON-MEMBER)*

Toronto, Ont.

THE heat transmission of ordinary cast-iron radiators has been the subject of researches for many years. The results obtained have been checked and re-checked, not only in the laboratory but also by practical experience in heating installations, so that the characteristics of this type are well known. The situation with regard to concealed radiators, however, is very different, because of the larger number of variables involved. The heat transmission, in such cases, is affected by differences in the forms of the radiators, by the size and form of the enclosure or stack and also by the nature of the fluid used as the heating medium.

In a previous paper,[1] the author indicated the extent to which the heat transmission was affected by some of these variables, and the following investigation was undertaken to throw some further light on the subject. The American Society of Heating and Ventilating Engineers has adopted the expression $\frac{(215-65)^{1.3}}{t_s - t_a}$ as a correction factor for changing the heat output obtained at any value of $(t_s - t_a)$ to that at the standard temperature difference. In this formula t_s is the temperature of the fluid in the radiator and t_a the temperature of the air entering the radiator enclosure. In the following work $(t_s - t_a)$ will be referred to as the *temperature difference*. This relationship is known to be true for cast-iron radiators and in the previous investigation it was proved also to apply to concealed radiators when steam was used as the heating fluid. In practice, tests have usually been made with steam, on account of its greater convenience, and the transmission expected from hot water at various temperatures has been calculated from these test results. Actual tests made with hot water, however, gave lower heat transmissions than those calculated from steam tests by means of this formula. The ratio of the output with hot water at a given temperature difference to that obtained with steam at the same temperature difference will be called the *heat output ratio*. In the previous work, this ratio varied from 0.6 to 1.0, under different conditions. The results obtained with hot water, together with some further figures obtained on radiator *B O* have been plotted on a logarithmic basis in Fig. 1. The lines obtained from the various radiators are very nearly parallel, the slope varying from 1.22 to 1.45. In drawing these, some of the outputs at very small temperature differences have been ignored as, in these tests, it was difficult to maintain steady conditions and errors of measurement were greater than those obtained at the larger temperature differences. Even so, these points are not far from the curves. It appears, therefore, that in the case of hot water tests, the output varies with $(t_w - t_a)^n$, the average value of n being about 1.35. Here, t_w is the arithmetic mean of the inlet and outlet water temperatures. This was used instead of the logarithmic mean for the reasons given in the previous paper.

Influence of Stack Height

The stack, or enclosure, is placed round the radiator or heater to produce a *chimney effect*, or to induce a flow of air over the heating surface. The static draught, therefore, depends on the height of the stack and thus the velocity of the air over the heating surface is a function of the stack height. The heat transmission coefficient is a function of a power of the velocity and therefore tends to increase with the stack height. As the velocity increases, however, the frictional resistance also increases and the time during which the air is in contact with the heating surface decreases, so that the air leaves the stack at a lower temperature. The heat output of any particular radiator, therefore, can be expressed as a function of the stack height and probably varies as $(H)^x$.

In Fig. 2[2], curves are given for radiators of different design, indicating the manner in which the heat output changes as the stack height increases. As a matter of

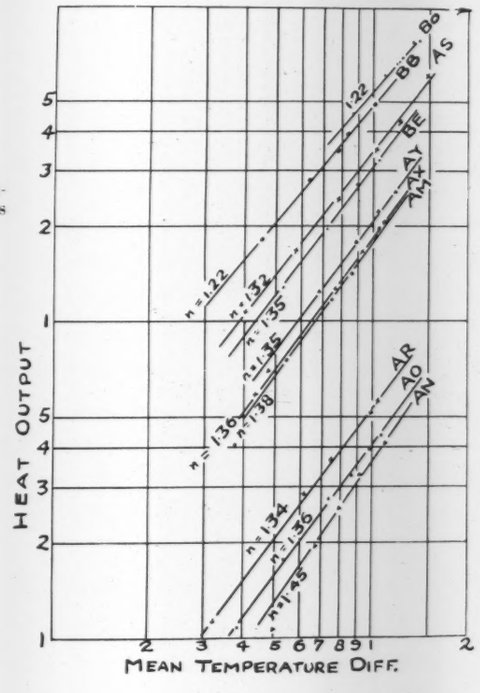


Fig. 1—Hot water tests—values of *n*

[1]Professor of Mechanical Engineering, University of Toronto.

[†]A. S. H. V. E. Journal Section, *Heating, Piping and Air Conditioning*, December, 1931.

[2]One square foot of radiation is 240 Btu per hour.

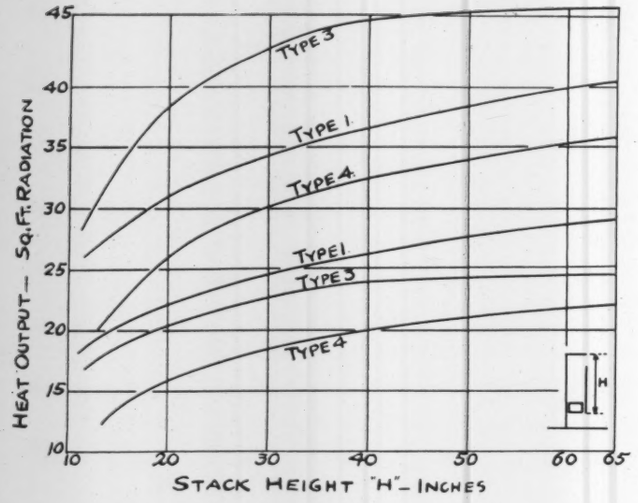


Fig. 2 (left)—Characteristic output curves

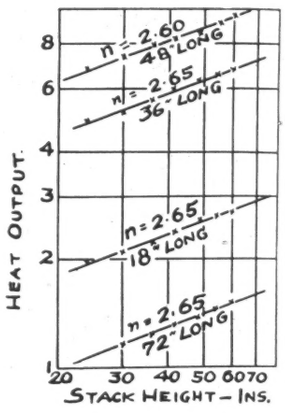


Fig. 3 (right)—Values of n for Type 2—width 6½ in.

convenience, the stack height H is taken from the bottom of the radiator to the top of the stack. From a strictly scientific standpoint this is probably incorrect, but it is a common commercial practice and does not affect the form of the curves or the validity of the comparisons.

The heat transmissions of about 450 radiators of different designs, widths, lengths and stack heights were then plotted on logarithmic paper and it was found that for any particular design of a definite width, the output could be expressed very closely by the following formula:[3]

$$H = a + b\,E^n$$

where H is the stack height (in.)
E is the heat output per hour (Btu)
a and b are constants

The value of n varied with the type and size of radiator, but its changes could be predicted with reasonable accuracy.

Four designs of radiator were investigated. All of them consisted of horizontal tubes or channels with fins radiating from them, between which the air was induced in a vertical direction.

Type 1 was composed of copper tubes of oval section, pressed into copper fins and the entire assembly dipped in solder to give good metallic contact between tubes and fins.

Type 2 consisted of circular copper tubes expanded into copper fins. The tubes and fins were larger than those in Type 1 and were further apart, so that the air stream was less finely divided, (similar to *A X* in the previous paper).

Type 3 was also made of circular copper tubes of smaller section than those in Type 2. These were expanded into aluminum fins, which were spaced closely as in Type 1, (similar to *A M* in the previous paper).

Type 4 was an iron casting with a cored hole in the center and ribs radiating on both sides, (similar to *A Y* in the previous paper).

In Types 1 and 2, the curves obtained with different stack heights were similar to those shown in Fig. 3. The four curves are drawn for radiators of the same width and number of tubes, but their lengths are 18, 36, 48 and 72 in. respectively. In all cases, however, the value of the exponent n is about 2.65. The other curves drawn for Types 1 and 2 have different values of n, but there is little variation in these values for any one group composed of radiators of the same type and width but with different lengths.

Types 3 and 4, however, behave somewhat differently. Fig. 4 shows that two values of n must be employed in these cases. The larger value is used up to a certain stack height, which is called for convenience, the *change point,* and beyond that, a smaller value of n must be used. In Fig. 4, curves are given for the same width of radiator with lengths varying from 14 to 60 in. The *change point* in all of these cases occurs at a stack height of 22 in. With lower stack heights, the output follows very closely the law $H = (a + b\,E^2)$ and above that height the appropriate formula is $H = (a + b\,E^{5.5})$. The different values of n below and above the change point for Types 3 and 4 are given in Table 2.

The constants a and b pertain to particular lengths and widths but, once determined, may be applied to any stack height without considerable error. A series of values was worked out for Type 1 and it was found that a is practically constant for any length and changes very little with the width. The value of a for Type 1 varies from —1 to —2 and for Type 4 it varies between 9.5 and 10.0. These differences in any one type are comparatively unimportant and may be neglected for commercial purposes. The value of b may be obtained by interpolation as it follows a definite curve for different lengths, thus:

Table 1—Average values of n for radiator types (1) and (2)

Type	Width In.	n	Type	Width In.	n
1	3⅜	4.08	2	6⅛	2.64
1	5⅜	4.07	2	8⅛	2.81
1	10⅝	4.08	2	8⅛	4.97

Table 2—Average values of n for radiator types (3) and (4)

Type	Width In.	Stack Hgt. at Change Point, In.	Value of n	
			Below Change Point	Above Change Point
3	3⅜	36	3.44	About 20
3	5⅜	27	2.12	9.20
3	7⅜	30	2.01	9.90
3	10⅝	22	1.46	7.50
3	14⅝	22	2.00	5.50
4	3½	22	1.53	3.50
4	4	22	1.52	3.52

[3]The form $E = c + dH^x$ may be used with equal facility; where c and d are new constants and $x = \frac{1}{n}$.

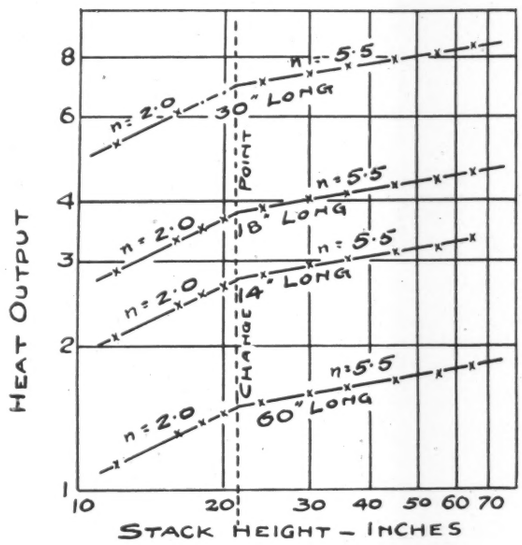


Fig. 4—Values of n for Type 3—width 14⅝ in.

Length of radiator—inches	18	24	30	48	60
Value of $b \times 10^4$.....	10.67	2.52	0.883	0.111	0.0421

Influence of Length

The heat transmissions of a large number of radiators of different types were plotted against their lengths in Fig. 5. In each case, if the stack height is constant, the heat transmitted is directly proportional to the length of the tubes, or of the heating surface.

The curves given in Fig. 5 were obtained by expressing the heat transmissions of each type as ratios of the output obtained with the smallest length of radiator. Thus, in Type 1, the heat transfer of a certain radiator 17½ in. long was 4930 Btu per hour. A similar radiator, 59½ in. long, gave an output of 19300 Btu per hour. The relative heat output was thus $\frac{19300}{4930}$ or 3.92. This relationship is true for all other sizes of this type and a single curve can be used for each form of radiator, as is shown in Fig. 5.

Influence of Form and Dimensions of Enclosures

The apparatus used in these tests was described and illustrated in the previous paper and the same method of testing was employed, the condensate being weighed at 10-minute intervals. Before any readings were taken, each heater was run under test conditions until the rate of heat transmission became constant. Tests were made under the following conditions:

(A) Constant air inlet area and varying air outlet area
(B) Constant air outlet area and varying air inlet area
(C) With different grilles on the air outlet
(D) With different grilles on the air inlet
(E) With stacks of different lengths
(F) With steam and hot water as heating media

The tests in series (A) to (E) inclusive, were all made with steam and the results were corrected to a standard temperature difference to facilitate comparison.

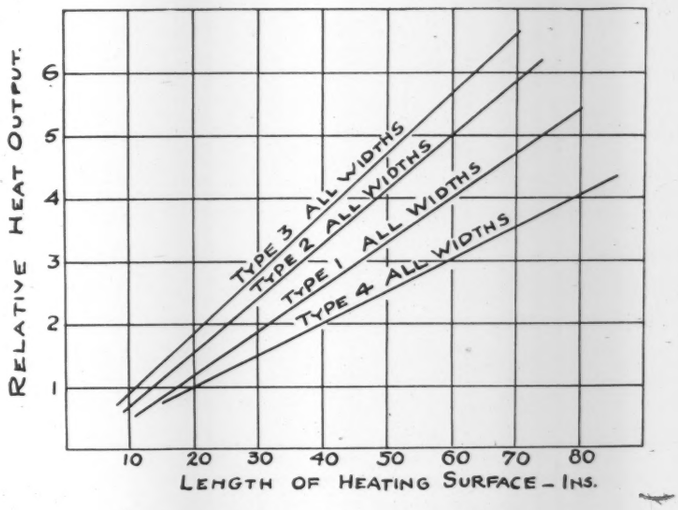


Fig. 5—Variation of heat output with length

Series (A) Varying Outlet Areas

Three radiators were tested, each with a constant inlet area and with constant stack heights. The outlet areas, (Fig. 6) were varied by increasing the height B and so reducing the height of the outlet opening D.

Radiator B O consisted of four copper tubes of streamlined section pressed into copper fins (Type 1 in the previous section). The end castings were of bronze and the steam and water connections were made on the under side of the castings. Each tube was 26⅛ in. long and there were 155 fins each 7⅜ in. wide by 2 in. high. The free area through the fins was 64 per cent of the gross area. The dimensions of the stack, (Fig. 6) were as follows:

$$A - 7\tfrac{3}{8} \text{ in.}$$
$$H = B + D = 30 \text{ in.}$$
$$C - 5\tfrac{3}{8} \text{ in.}$$

The slots C and D extended along the whole length of the stack, so that the ratio of the inlet and outlet areas to the stack area are represented by $\frac{C}{A}$ and $\frac{D}{A}$, respectively.

In series (B) it was found that the optimum value of C was 8 in. and the tests were repeated with that inlet area and with varying values of D.

Radiator B P was of similar construction to B O but was 5⅜ in. wide. In this case there were three copper tubes instead of four, but the length of the radiator, the size of the tubes and the number of fins were the same as before. The dimensions of the stack were:

$$A - 5\tfrac{3}{8} \text{ in.}$$
$$H = B + D = 30 \text{ in.}$$
$$C - 5\tfrac{3}{8} \text{ in.}$$

The free area through this radiator was 66.2 per cent of the gross area.

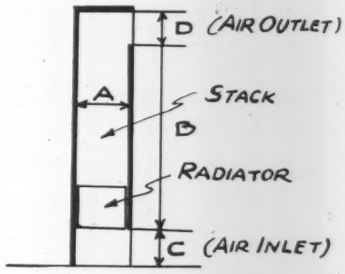


Fig. 6—Arrangement of radiator and enclosure

Radiator *B Q* was made of cast iron and was similar in form to radiator *A Y* in the previous paper (Type 4). It consisted of a single casting 29½ in. long and 4 in. wide with a passage for the heating fluid down the center. On each side of this passage were 100 cast-iron fins, each 1½ in. long. The height of the radiator was 35⅝ in. and the stack dimensions were:

A — 4 in.
$H = B + D = 30$ in.
C — 4¼ in.

The free area through the radiator was 56.6 per cent of the gross area.

The test results obtained with steam are given in Fig. 7. The curves (Fig. 7) show that, with all of these radiators, the highest output is obtained when the outlet area is between 80 and 100 per cent of the cross sectional area of the stack, or when the ratio $\frac{D}{A}$ is between 0.8 and 1.0. All of the curves indicate that the output is reduced when the outlet area exceeds the stack area. This may be due to a reduction in the effective height of the stack. When the air leaves the stack horizontally, as it does in these cases, most of it rises to the top of the stack before changing its direction. It is possible that if the outlet area is very large, a greater proportion of the heated air escapes from the opening *D* before reaching the top, and in this way the chimney effect may be reduced.

Alternatively, eddy currents or down draughts may be produced when the outlet opening is made too large. This seems to be indicated by the scattering of points in Fig. 7 (Radiator *B O*) when the outlet area was increased to about 180 per cent of the stack area. Further, tests made under these conditions were somewhat unsteady.

The results obtained do not vary greatly for outlet areas exceeding 70 per cent of the stack area, and therefore if the area provided is greater than this amount, no great exactitude is necessary in design or construction.

Series (B) Varying Inlet Areas

In this series, dimension *D* was kept constant and *C* was varied, the *stack height* and the position of the radiator being unaltered.

Radiator *B O* was first tested, the height of the outlet (D) being 6 in., corresponding to a ratio $\frac{D}{A}$ of 0.815.

Radiator *B P* was then tested with an outlet height *D* kept constant at 5⅜ in., giving a ratio $\frac{D}{A} = 1.0$.

Radiator *B Q* was also tested with varying inlet openings, the dimension *D* being kept at 4¼ in., or $\frac{D}{A} = 1.06$.

All of these tests, therefore, were made with the outlet areas at about the optimum values, and the results obtained are given in Fig. 8.

The output curves given in Fig. 8 are all similar in form and indicate that the best results are obtained when the inlet area is about 10 per cent greater than the stack area. From the curves, it would appear that there is a maximum beyond which the heat output begins to fall, thus confirming the conclusions derived from tests described in the former paper.

The curves also indicate that the output is more sensitive to changes in the inlet area than it is to changes in the outlet area.

From the tests in Series (A) and (B) a general rule can be deduced for radiators of this form, namely, that the areas of the inlet and outlet openings, respectively, should be as nearly as possible equal to the cross sectional area of the stack or enclosure.

Series (B) Varying Inlet Areas

The experiments in Series (A) and (B) were made with plain rectangular openings of the full length of the stack to avoid possible complications and variables of unknown extent. These tests were now repeated with the same radiators but with grilles of different forms placed alternately over the inlet and outlet openings.

Fig. 7—Variation of output with outlet area

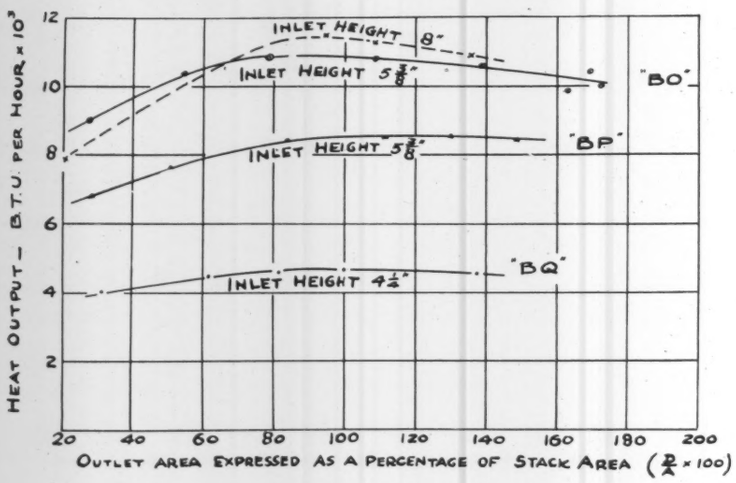
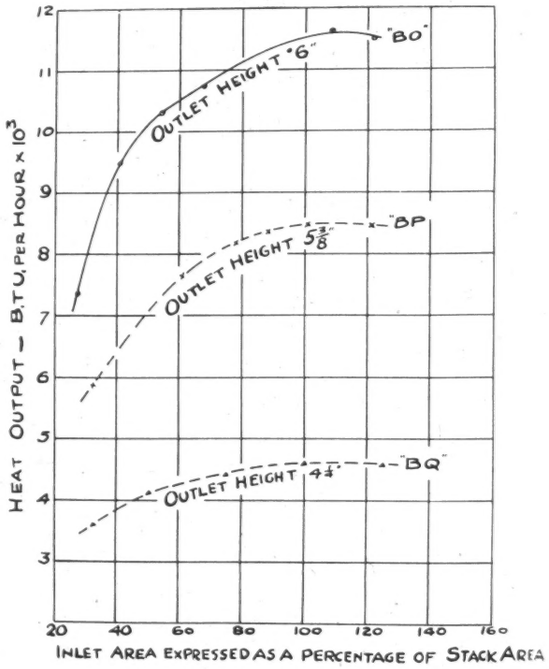


Fig. 8 (right)—Variation of heat output with air inlet area



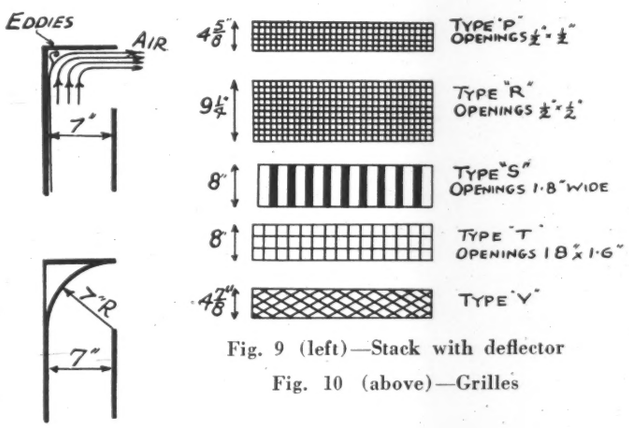


Fig. 9 (left)—Stack with deflector

Fig. 10 (above)—Grilles

In the first place, however, a deflector was placed in the top of the stack of radiator *B O*, as shown in Fig. 9. The radius of this was 7 in., so that the thickness of the airstream round the bend was the same as that at the outlet. The object of this was to ascertain whether the output of the radiator was restricted by the rectangular top used in the previous experiments. It was thought that eddies, and consequent losses, might be reduced by directing the flow of air round a curve instead of making it impinge on a flat plate. The following were the comparative results obtained:

Table 3—Results of Tests

	With Deflector		Without Deflector	
Test No.	45	46	47	48
Steam temperature — F.	219.2	218.8	218.8	218.8
Air temperature — F.	75.5	79.2	81.8	84.8
Temperature difference — F.	143.7	139.6	137.0	134.0
Lb condensate per hour	11.51	11.05	10.66	10.26
Corrected output Btu per hour	11280	11250	11140	11020

From Table 3 it appears that the use of a deflector increased the output by about 180 Btu per hour, or approximately 1.6 per cent. Thus, the advantage of adding the deflector is almost negligible.

It should be stated here, that the tests on hot water described in Series (F) were actually made between Series (B) and (C). After the hot water tests had been performed on radiator *B O* the outputs obtained with the steam tests were always about 300 Btu per hour less than they were before. This was possibly due to the deposition of a thin layer of scale or other foreign matter inside the tubes, and this difference must be taken into account when estimating the effect of the grilles.

The inlet in all cases was a plain rectangular opening of the optimum height (8 in.) and equal in length to the length of the stack.

Test No. 49 was made with a standard grille (Type P, Fig. 10) consisting of vertical and horizontal bars each 3/16 in. wide leaving 301 holes each ½ in. square. Thus, the total area for the air passage was 75¼ sq in., or approximately 55 per cent of the gross area of the grille.

Test No. 50 was made with two of these grilles joined together (Type R, Fig. 10) giving a total area of 150.5 sq in.

Test No. 51 was performed with a special grille (Type S) made of 12 strips each ½ in. wide, placed vertically across the rectangular outlet opening. This gave a net area of 190 sq in. or nearly 80 per cent of the gross area, which was 8 in. high by 29¾ in. long. The following results were obtained:

Table 4—Results of tests

Test No.	49	50	51
Steam temperature —F	218.8	218.8	218.8
Air temperature —F.	78.9	70.3	74.2
Temperature difference —F	139.9	148.5	144.6
Lb condensate per hour	9.35	11.66	11.36
(*a*) Corrected output Btu per hour	9450	10850	11100
$\frac{\text{Net area through grille}}{\text{Area of stack}}$ — per cent	35.2	70.4	86.7
(*b*) Output for the same area of plain outlet from Fig. 7 — Btu per hour	8800	11000	11450

The last line in Table 4 was obtained by looking up the output in Fig. 7 for outlet areas of 35.2, 70.4 and 86.7 per cent of stack area, respectively. After allowing for the loss of output due to the circumstances previously described, there is very close agreement between the two sets of results marked (*a*) and (*b*), respectively.

A number of tests were made under the same conditions as those in Series (A) with the exception that a number of grilles of different areas were placed over the outlet. Grilles with ½ in. square holes were used in Tests 63 to 66 inclusive. That used in Test 67 consisted of vertical slots (Type *S* Fig. 10), while that in Test 68 was similar to Type *T* (Fig. 10).

Test 69 was made with a grille constructed of expanded metal (Type *V* Fig. 10). This had a net area which was 75 per cent of its gross area, but the different directional effect of the openings may account for the high output obtained in that test. The results are given in Fig. 11. It will be seen from the curves that the different forms of grille give fairly consistent results and at the optimum area the output is very slightly below that for an unobstructed outlet of the same net area.

These tests were performed with a constant inlet height of 4¼ in. and with grilles on the air outlet of Type *P* (Fig. 10). The results obtained are given in Fig. 11. In this case, the effect of the grille is somewhat greater, the maximum output being reduced by about 4½ per cent.

It is an interesting fact that the curves with and without the grilles for both radiators *B P* and *B Q* are practically coincident below a net outlet area equal to 60 per cent of the stack area.

Series (D) Effect of Grilles on Air Inlet

Radiator *B P*. This was tested with a constant outlet height of 5⅜ in. (no grille) and with grilles similar to Type *P* (Fig. 10) placed on the inlet area. The results obtained are given in Fig. 12. The curves reveal the fact that the outputs obtained with a grille on the inlet opening are higher than those obtained with the same net area and no grille. Both curves appear to give about the same maximum result.

Radiator *B Q*. A similar set of tests was made with the same type of grille on the inlet opening and an unobstructed outlet slot 4¼ in. high. The results are given in Fig. 12. These curves also indicate that the grille is advantageous when used with small inlet area.

The conclusion to be drawn is that, as the inlet area

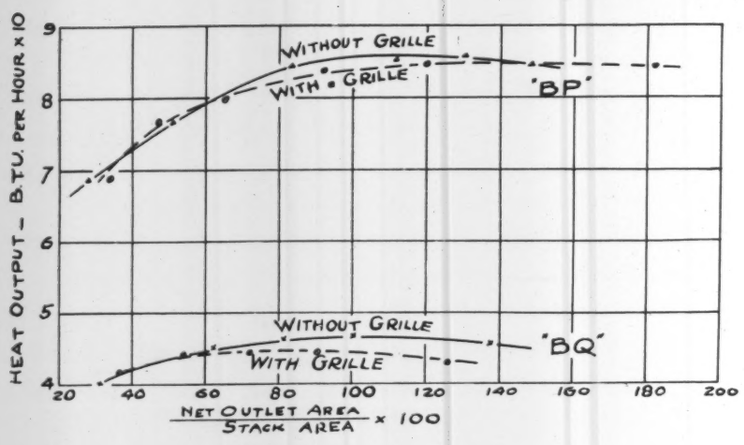


Fig. 11—Effect of grilles on air outlet

is reduced, the advantageous effect of the increased turbulence produced by the grille is greater than the detrimental effect of the increased frictional loss. If the inlet area is small, it is apparently beneficial to divide it into a number of small openings and so to increase the turbulence of the air entering the radiator.

Series (E) Influence of Stack Length

Tests made by the author on a number of standard radiators gave results which, in some cases, were 15 to 20 per cent below the catalog ratings. This was not due to experimental error, because these discrepancies occurred between tests on other radiators, the results of which were in close agreement with the catalog ratings. On taking a general survey of these tests, it was found that those radiators which gave low outputs had stacks which were from 10 to 12 in. longer than the radiators themselves. The spaces at each end were left to accommodate the piping connections. One such test was made in the presence of the representatives of the firm which made the radiator, and it was agreed that the output was about 15 per cent less than the catalog rating. The stack was then removed and the test continued on the bare radiator. The quantity of condensate leaving the radiator increased immediately, and the test gave an output equal to the catalog rating. The author does not consider that this would have happened with other types of radiator, but this particular form had a fairly large radiating surface, and in this case, the faulty design of the stack impeded the flow of air instead of assisting it.

This experience, combined with others mentioned, caused the author to make a short investigation into the influence of stack length on heat output.

Radiator *C C* (Type 1), which was 18 in. in length, was placed in a standard enclosure 36 in. long. The enclosure fitted the radiator at the sides and the stack height was 24 in. The corrected heat output under these conditions was 3190 Btu per hour. The test was then repeated with vertical partitions placed in the stack, leaving a space 28 in. long. The clearance at each end of the radiator was thus 5 in., and under these conditions the corrected output was 3360 Btu per hour. The partitions were then placed close to the ends of the radiator, giving an enclosure 18½ in. long, and the heat output increased to 4460 Btu per hour. Thus, when the enclosure was made 10 in. longer than the radiator, the heat transmission was approximately 25 per cent less than the standard rating. A still greater loss was incurred when the clearances were increased to 9 in. at each end.

A similar radiator, 36 in. long, was tested alternately in steel and wooden enclosures. The heat output obtained with the steel enclosure was 9800 Btu per hour, and that with the wooden enclosure was 10,020 Btu per hour. This seems to indicate that the length of the enclosure is far more important than the materials of which it is constructed.

Series (F) Effect of Heating Medium

In the previous investigation, heat output curves were drawn for steam and hot water at different temperatures and it was shown that, in most cases, the heat transmitted from hot water was less than that from steam and at the same mean temperature. The difference varied from 0 to 29 per cent, with different designs. The higher radiators generally gave the smaller losses and therefore particular attention was paid to this factor. One difficulty in the previous investigation was, that it was impossible to get temperature differences between hot water and air exceeding 120 F., whereas the lowest temperature difference obtainable between steam and air was about 140 F.

The hot water tank was raised to enable greater temperature differences to be maintained and another series of tests was made on Radiator *B O*. The results are given in Fig. 13.

The ratio of the output on hot water to that on steam at the same temperature in this case is about 70 per cent, which agrees very well with the ratio of 71 per cent given in the previous paper for a Radiator *A M* of similar design and size.

A similar set of tests was made on Radiator *B Q* which is similar to Radiator *A Y* in the previous series (Type 4). In this case the ratio of hot water to steam output was 83 per cent, as compared with 77.2 per cent in the previous series.

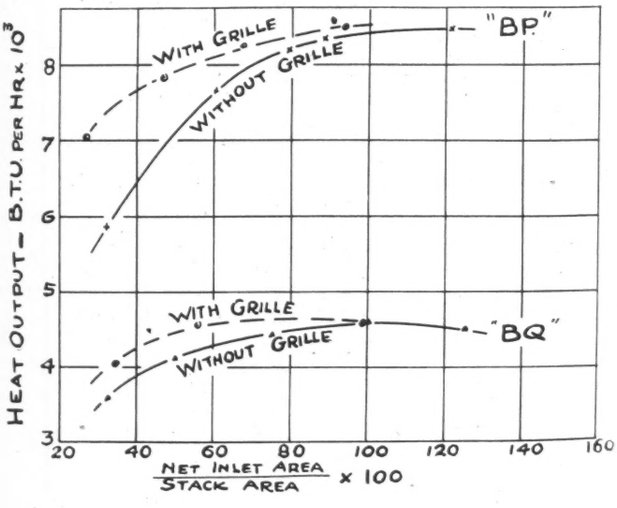


Fig. 12—Effect of grilles on air inlet

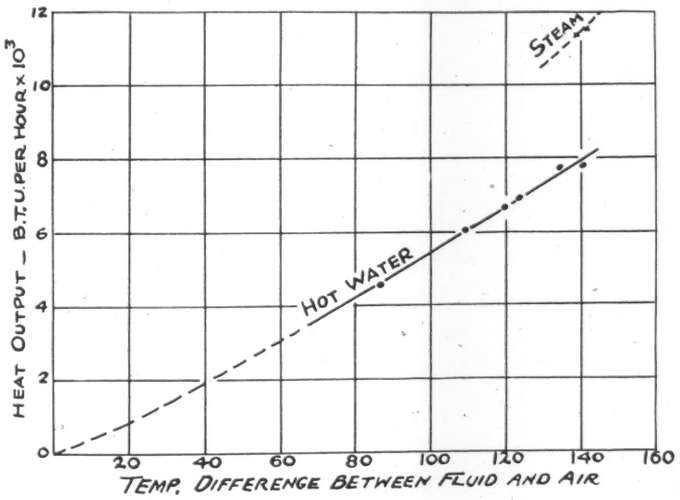


Fig. 13—Steam and water tests (*BO*)

The height of this radiator was 4 in. and it was considered that the ouput ratio might be increased by making a similar radiator of greater height. Three of these were made, each consisting of a narrow rectangular cast iron box with fins cast on the outside (Fig. 14). The dimensions were as follows:

Table 5

Radiator	*BR*	*BS*	*BY*
No. of sections in parallel	1	2	2
No. of fins per section	18	18	27
Length of radiator — in.	15	15	15
Height of fins — in.	10	10	8⅞
Width of fins — in.	2⅞	2⅞	2⅞
(*a*) Hot water output at 145 F temp. diff. (Btu per hour)	1608	3390	3150
(*b*) Steam output at 145 F temp. diff. (Btu per hour)	1710	3630	3280
Ratio $\frac{a}{b}$ per cent	94.1	93.5	96.1

These tests indicate the importance of height in connection with the relative outputs with hot water and steam. Radiators *B R*, *B S* and *B Y* were similar in form to Radiators *A Y* and *B Q*, and were made of the same material, the principal difference being that the former were from 2¼ to 2½ times the height of the latter pair. The effect of this was to increase the output ratio from approximately 80 to about 95 per cent. Evidently height is an advantage in hot water radiators, probably because it gives a greater time of contact between the metal and the air.

Radiator *B X* (Fig. 14), was then tested both with steam and hot water, and readings of the outside temperature of the copper tube were taken by thermocouples placed in the position shown on the drawing. These were at the beginning and end of the fluid path, respectively, and at three intermediate points approximately equal distances apart. The readings obtained are shown in Fig. 15 and the test results in Table 6.

Table 6—Comparison of tests with steam and hot water

Steam Test (Test 111)	
Steam temperature — F	219.1
Mean temp. of outside of tube — F	203.5
Mean temp. diff. between steam and tube — F	15.6
Mean air temperature — F	68.75

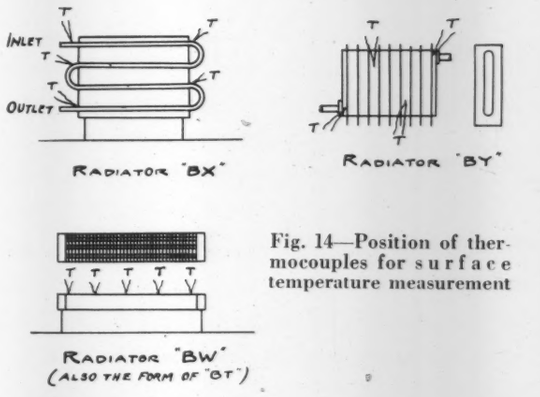


Fig. 14—Position of thermocouples for surface temperature measurement

Mean temp. diff. between tube and air — F	134.75
Heat output corrected to 145 F — Btu/hr	6750
Water Test (Test 113)	
Mean water temperature — F	195.9
Mean temp. of outside of tube — F	174.2
Mean temp. diff. between water and tube — F	21.7
Mean air temperature — F	73.35
Mean temp. diff. between tube and air — F	100.85
Heat output corrected to 145 F — Btu/hr	6200

The figures given in Table 6 indicate that the heat output ratio is $\frac{6200}{6750} = 92$ per cent, which agrees with the ratios of 93.5 and 91.2 per cent obtained on similar radiators in the previous investigation (Radiators *A S* and *B B*). The correction factors used, however, are based on the temperature differences between steam and air, and hot water and air, respectively. This is incorrect, as the heat transfer actually takes place from the *outside* of the tubes. A fairer method, therefore, would be to compare the heat transfer in the two cases in terms of the temperature differences between the metal and the air.

From Table 6 it is evident that the mean temperature drop across the tube is 15.6 F in the case of steam, and 21.7 F in the water test, the temperature differences between the tube and air being 134.75 F and 100.85 F, respectively. The *actual* heat transfers in these cases are 7080 and 4880 Btu per hour. Correcting each of these for a temperature difference between tube and air of 145 F, we get heat transfers of 7850 Btu per hour for steam, and 8000 for water. These are within the limits of experimental error and show that the differences observed between the two fluids, are due to the fact that the temperature difference between the water and the tube is greater than that between the steam and tube.

Radiator *B W* (Fig. 14) was then tested in the same manner, thermocouples being placed at equal intervals along the middle tube of the three and the following results were obtained:

Table 7—Comparison of tests with steam and hot water

Steam Test (Test 114)	
Steam temperature — F	219.1
Mean temperature of tube surface (outside) — F	206.6
Mean temp. diff. between steam and tube — F	12.5
Mean air temperature — F	78.8
Mean temp. diff. between tube and air — F	127.8
Heat output corrected to 145 F — Btu/hr	8850
Water Test	
Mean water temperature — F	199.5

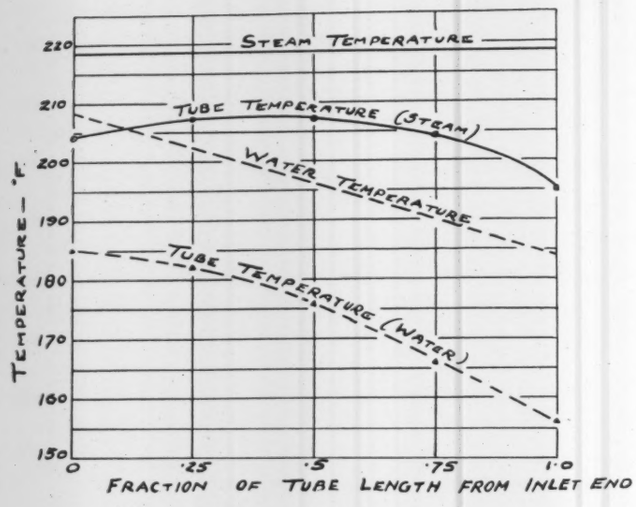


Fig. 15—Tube and fluid temperatures

Mean temp. of outside of tube — F	171.0
Mean temp. diff. between water and tube — F	28.5
Mean air temperature — F	78.75
Mean temp. diff. between tube and air — F	92.25
Heat output corrected to 145 F — Btu/hr	7620

The apparent output ratio is thus $\frac{7620}{8850} \times 100 = 86.2$ per cent. Correcting these figures for tube temperatures, as in the previous case, we get a heat output for steam of 10060 Btu per hour, and for water 10720 Btu per hour. Here again, the figures are in much closer agreement than they were before. The tube temperature is 12.5 F below the steam temperature and 28.5 F below the water temperature.

A similar comparison was attempted in connection with the cast iron Radiator *B Y* (Fig. 14), but as this did not consist of simple tubes, the mean temperatures of the surface and of the water were difficult to get. The average results were as follows:

Table 8—Comparison of tests with steam and hot water

Steam Test (Test 116)	
Steam temperature — F	219.0
Mean temp. of outside surface — F	213.0
Mean temp. diff. between steam and surface — F	6.0
Mean air temperature — F	70.95
Mean temp. diff. between surface and air — F	142.05
Heat output corrected to 145 F — Btu/hr	3280
Water Test (Test 118)	
Mean water temperature — F	187.9
Mean temp. of outside surface — F	184.2
Mean temp. diff. between water and surface — F	2.7
Mean air temperature — F	66.2
Mean temp. diff. between surface and air — F	118.0
Heat output corrected to 145 F — Btu/hr	3150

From these figures the apparent heat output ratio is 96 per cent, but applying correction factors, as before, based on the surface temperatures, the corrected output on steam becomes 3440 Btu per hour, and that on water 3360 Btu per hour. The agreement is fairly satisfactory, but it is doubtful whether the true mean temperature of the water was obtained in this case. The sectional area of the cast passage in this radiator was about 6 in. high by ⅞ in. wide, so that the water velocity was very much less than those in the tubes of Radiators *B X* and *B W*, and this may have some influence on the temperature difference between water and surface in this case. The average velocities were:

Radiator *BX* — 0.210 ft/sec
Radiator *BW* — 0.307 ft/sec
Radiator *BY* — 0.0153 ft/sec

The higher and lower critical velocities are:

	H.C.V.	*L.C.V.*
Radiator *BX*	0.55	0.087 ft/sec
Radiator *BW*	1.03	0.161 ft/sec

Thus, the actual water velocities, in both cases, are in the unstable region between the higher and lower critical velocities.

Many papers have been written on the subject of heat transfer and a large number of them contain mathematical analyses of heat flow. However, most of these are for simple forms and contain assumptions which reduce their application to a few practical cases. Concealed radiators consist of small tubes with large fins, which divide the air into a number of thin streams. The velocities induced by convection are very low, the air flow is turbulent and the frictional losses are unknown and very difficult to measure. In view of these facts, it is unlikely that mathematical analyses can contribute very much of practical value to the designers of such apparatus.[4] It is probable, therefore, that for some time at least, progress will be made by the experimental route.

The following conclusions are indicated by the investigation detailed in the preceding pages:

(1) The heat output of a concealed radiator, when heated by water, varies with (temperature differences),[1.35] within the limits of experimental error.

(2) The heat output of any radiator may be obtained from the formula $n\sqrt{\frac{H-a}{b}}$ where H is the stack height, a and b are constants. In some cases, two values of n must be employed, below and above a certain stack height, here called the *change point*.

(3) Whether the air inlet and outlet areas are open slots, or provided with grilles, the best proportions are obtained by making the net inlet and outlet areas, respectively, equal to the sectional area of the stack.

(4) The heat output may be improved somewhat by providing a grille on the air inlet area.

(5) A curved deflector in the top of the stack makes little difference to the heat output.

(6) The form of the grilles used does not appear to be important, provided the net area is constant.

(7) Spaces must not be left between the ends of the radiator and the enclosure to accommodate piping connections. The enclosure must be a close fit over the radiator.

(8) High radiators give better heat output ratios than low ones. The advantage of this is reduced in practice by the smaller heat transmission for every inch added to the height. From an economical standpoint, the low type of radiator is to be preferred.

(9) The difference in heat output between water and steam is due to the lower tube temperature in the former case. If the external tube temperatures are taken as a basis, the two results are practically the same. The heat transmission ratio can probably be improved by increasing the water velocity by means of a pump.

The author's thanks are due to Mr. J. N. Corry, B. A. Sc., for his assistance in the experimental work.

[4]See Calculation of Heat Transmission by Fishenden & Saunders, Chapter VI, for a comprehensive survey of the possibilities in this connection.

Testing and Rating of Air Cleaning Devices Used for General Ventilation Work*

By **Samuel R. Lewis† Chicago, Ill.**
MEMBER

FOR years there has been widespread discussion and controversy on the subject of how air cleaning devices should be tested and rated. No matter how this testing was done, however, an efficiency of dust removal of better than 97 per cent has nearly always been claimed in the literature of manufacturers, whether the air cleaning device was the crudest old-time water spray or the most refined modern fabric filter or viscous coated impact surface. This high claim for arrestance of dust was safe enough with some methods of testing because no two people could agree on how to prove or disprove it.

Who, of the ordinary busy world, not especially interested in the fabrication of air cleaning devices, has given much thought to this question of measuring dust removing efficiency? Who has considered particularly whether the advertised efficiency represented a new clean device or whether it represented the conditions at some average time during the period of operation between clean and necessary-to-be-cleaned? Who knew or worried whether the efficiency was determined by laboratory test or by field test?

Anyway, how could the air cleaning efficiency be protected by a shot gun guarantee if one realized that no two dusts are alike? There is a different kind of dust, for instance, in Chicago from that in New York, and the dust in St. Louis isn't like either of these, nor like Pittsburgh dust. The dust in the Chicago loop is different in concentration and type from that on the Midway, and an air cleaning device on the 20th story taking air through a window has a very different problem from the air cleaning device in the sub-basement of the same building, taking its air from grade level in the alley.

The soot from bituminous coal and oil combustion, the most destructive factor in modern ventilation work, defeats very easily the 98 per cent efficiency hopes of the air washer which uses the imperfectly wetted impact surfaces. The microscopic fly ash from pulverized bituminous coal and from anthracite coal defeats nearly all air cleaning devices except the most effective types of viscous coated metal impact surfaces. The lint and fibrous material frequently encountered in the air in clothing and textile manufacturing districts tends to clog up the air passages of most types of viscous coated filters and makes it advisable to use highly specialized air cleaning devices in such districts. The unoiled, paper-like or fabric-like types of air cleaning devices serve best in these circumstances.

The manufacturer of air cleaning devices therefore must use his shot gun efficiency guarantee with mental reservations, and, lest he get himself into trouble, has been for some time endeavoring to devise, with the help of research, some uniform and assuredly accurate method of testing and rating.

There is a fairly satisfactory method now in use for testing and rating fans. Within the author's memory, however, there was a time when most fan manufacturers rated their product on hope and guess rather than on knowledge and truth. If the ordinary contractor who must purchase a fan knew his business, he knew that the published fan rating was like a list price, subject to a discount of anywhere from 30 to 60 per cent, and even then it would not be unusual for the contractor to be compelled to insert intermediate blades in the fan wheel or to increase the fan speed and the motive power somehow, before he could escape the responsibilities of his guaranteed air delivery.

This situation concerning fans happily has been cleared up following the adoption of a Standard Code for Testing and Rating Fans and Blowers, and the ultimate consumer, the contractor, the engineer and the manufacturer all have benefited thereby.

The same situation concerning the rating of air cleaning devices shrieks for resolution and to be fair in the matter it must be stated that the manufacturers of air cleaners are cooperating fully in this movement.

How to measure the dust in air, so as to evaluate air cleaning devices for general ventilation work, is the great question. Sticky surfaces such as pitch-coated, ruled glass slides can have some air impacted against them out of a syringe; then the sticky surfaces can be placed under a powerful microscope. The tiny area of the microscope's cognizance will show visible dust spots or dust colonies, and these can be counted. If one little ruled area of the sticky glass has 100 dust particles, then the whole exposed sticky area probably has 100 particles for each similar ruled subdivision, perhaps 10,000 particles per square inch. If one fraction of a cubic foot of the air forced against the sticky surface discloses 10,000 dust particles, probably each cubic foot has the same dust burden and if there are 1,000,000 cu ft per hour passing by, perhaps each one of these million cubic feet will have the same dust burden. The counting of the dust particles through a powerful microscope, it has been observed, cannot easily be duplicated by different people. One man will see 110 particles, while another will see 100, and another will see only 85, even though all use the same apparatus and the same ruled area. An error of seemingly trifling dimensions

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in the microscope count will be magnified to almost unbelievable and to thoroughly unacceptable ranges so that this method of testing air cleaning devices for rating purposes is therefore open to question.

A second method of determining the amount of dust in air, employs a tube of fine material such as sugar. A sample of dusty air is drawn slowly through the sugar, which strains out the dust. The sugar can be weighed before and after its dust-catching experiences and the weight of dust caught from a given volume of the air is an index of the probable amount of dust in each cubic foot of the main air stream. This method of dust determination has an advantage over the visual counting method in that any number of men can weigh the same article on an accurate scale and all will agree. The scale is more accurate than the eye-brain combination. The optimist has less chance to play on his hopes with a scale-balance weighing to a ten thousandth of a gram than with the inconsistent human eye. The sugar of course may pick up moisture from the air, or may lose it to the air while catching the dust.

A third method draws a sample of the dusty air through a filter paper. The paper clogs and interposes increasing resistance as the dust accumulates. This increase in resistance, gauged with air volume, evaluates the dustiness.

A fourth type of dust determinator brings about contact by a measured sample of the dusty air with a surface which is sticky, and gauges the dust by weighing the tube or the plate which supports the sticky substance.

Another dust collecting scheme uses an electric precipitator for a measured fraction of the main stream, and weighs the precipitated dust.

There are a great many other types of dust determinators. Many of them under laboratory conditions will give consistent results and will repeat their performances day after day provided that all of the conditions day after day are the same.

The various Society committees which have labored to produce a Code for Testing Air Cleaning Devices, however, have concluded that before a code could be effective an approved dust determinator must be selected. Their labor of many years has not been rewarded with a shot-proof apparatus.

Is it not now apparent that dust in air is of such extreme variability that a limited determinator for rating air filters is impracticable?

Will it not promote the best interests of all concerned if this fact is recognized and agreement is reached upon the point of testing for rating of air cleaning devices for general ventilation work by means of some non-proprietary scheme, of reasonably consistent performance, within the dust ranges commonly encountered in ventilating systems? If an affirmative answer to these two questions can be obtained it will simplify very greatly the labors of the Committee on Atmospheric Dust and Air Cleaning Devices.

In recent months it has been the author's privilege to make hundreds of tests of air cleaning devices under laboratory conditions. The tests were made for comparative purposes and covered about 100 different types of alleged air cleaners.

The work was started, using the proposed code of the committee, which was presented for study at the June 1932 meeting of the American Society of Heating and Ventilating Engineers at Milwaukee, Wis. As the work progressed various changes in the apparatus and methods proved desirable. Since perhaps not more than 20 members of the Society are familiar with the subject, the details which are outlined here may be interesting.

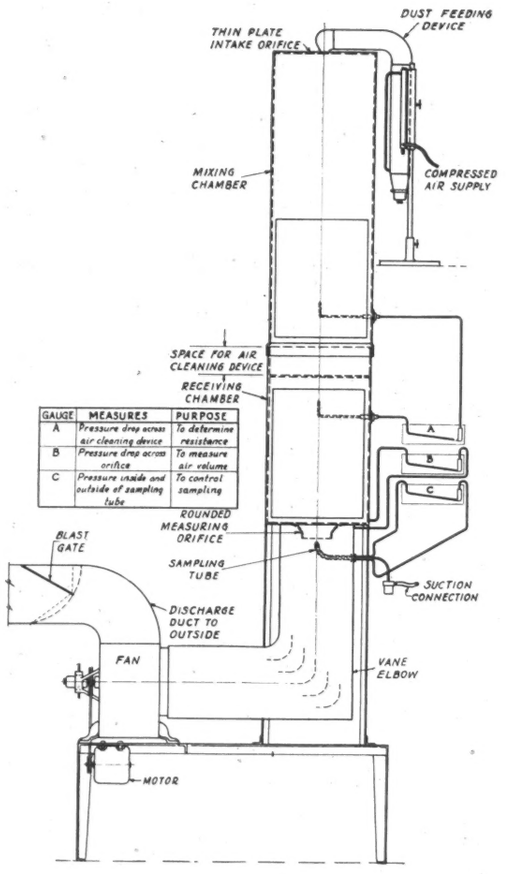

Fig. 1—Testing apparatus for air cleaning devices

Description of Test Apparatus

The testing apparatus, Fig. 1, shows the arrangement for using the weight method of determination. The air tunnel is vertical, to reduce the tendency of the heavier dust particles to fall out of the air stream before they reach the air cleaning device or the sampling tube.

With a horizontal air tunnel such precipitation of the heavier particles is evident in the mixing chamber. The agglomerated dust masses which break away from the device being tested, between it and the sampling tube also are much in evidence in any horizontal receiving chamber to leeward of the air cleaning device.

In the dust sampling tube, Fig. 2, the orifice faces the cleaned air stream. When the pressure is balanced across the Gauge *B* the air velocity induced by the pump suction connection through the crucible and the Orifice *O* must be the same as that maintained by the exhaust fan in the duct into which the Orifice *O* is inserted.

Fig. 3 is one form of dust feeding device. The bottom of the dust hopper has a long fine screw thread so

that the device easily may be rotated one revolution or so, back and forth. The clearance between the end of the compressed air Pipe *A* and the cup is adjustable by the Screw *B*. The stirring rod, attached to the cup, rotates with it and thus breaks up any arching over of the dust. Manipulation of the dust hopper bottom only occasionally is necessary.

The question, "How to measure the volume of air which passes the air cleaning device?" is of prime importance.

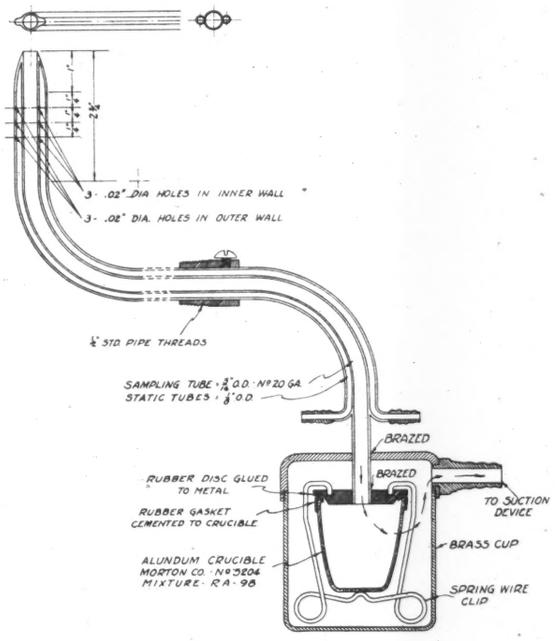
3 - .02" DIA HOLES IN INNER WALL
3 - .02" DIA. HOLES IN OUTER WALL
¼" STD. PIPE THREADS
SAMPLING TUBE - ¼" O.D. NO 20 GA
STATIC TUBES - ⅛" O.D.
BRAZED
BRAZED
RUBBER DISC GLUED TO METAL
RUBBER GASKET CEMENTED TO CRUCIBLE
ALUNDUM CRUCIBLE MORTON CO. NO 3204 MIXTURE - RA-98
TO SUCTION DEVICE
BRASS CUP
SPRING WIRE CLIP

Fig. 2—Sampling tube

It is not too easy to measure the volume of air passing through the air cleaning device from which the sample which will be tested for dust shall be taken, nor is it easy to measure accurately the volume of the sample of dust-carrying air itself. The oldest scheme for air velocity measurement and the only one available now for certain limited purposes, involves using an anemometer. An anemometer of course is only a geared wind wheel which expresses the air-flow speed. If the instrument is in good condition; if it is held squarely to the plane of the air current; if the air current is not too fast and if it is not too slow to come within the scope of the particular anemometer; if the transverse cross section area of the air-way is measured accurately at the plane in which the anemometer is placed; if the stop watch is accurate; if the reading of the dials and of the stop watch are coordinated perfectly; then the anemometer method will approximate the volume of air in the main air-way.

In general, however, engineers do not accept anemometer readings as more than approximate, though they are of great value for relative determinators when adjusting and equalizing the air flow through the different ventilating outlets and inlets in any given building.

If, in a straight air-way or liquid-way, there shall be interposed a slight reduction in area followed by a return to normal area, and if the air or liquid is being forced at a reasonable speed along the channel, the volume of the air or liquid which is passing can be computed with great accuracy provided that the following factors are known: the area of the passageway at the point of maximum restriction, and the difference between the static pressure up-stream and that down-stream from the reduction, or orifice. This orifice, or venturi tube method of measuring gases or liquids, is readily installed and is exceedingly reliable and accurate, and as its use reduces liability of human error to a great extent, the method is standard for laboratory determinations. It is also the preferred method for a great many field observations.

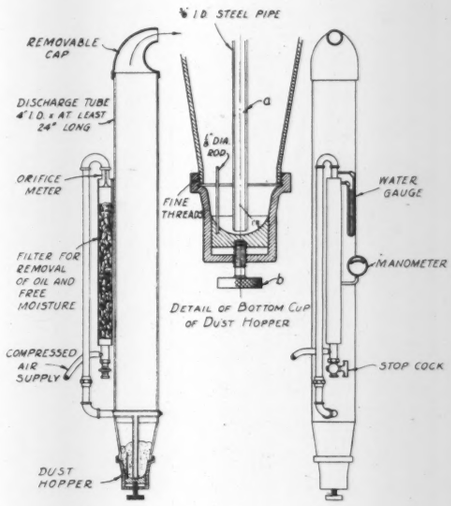

Fig. 3—Dust feeder

Air volume flowing along a duct also may be measured by a pitot tube. This method is preferable to the anemometer method but requires much higher velocities than those which often occur in ventilating systems. The tube compares the pressure of the air moving along the duct against atmospheric pressure outside of the duct and if these pressures are taken by traversing the tube in many short stages across the air-way, the computed velocities may be averaged to an accurate result. The venturi tube method, however, in a test set-up for rating air cleaning devices is very much to be preferred to the pitot tube method since the former set-up may be permanent and the influence of the human element is minimized. The operator merely reads the scale, just as he does with the dust weighing arrangement.

How shall the volume of the air samples taken from the main air-way be measured, before making dust content analysis?

Small volumes of air under appreciable pressure can be measured accurately and practically by a wet gas meter. This method has been employed successfully by the Research Laboratory of the American Society of Heating and Ventilating Engineers in measuring infiltration through window cracks and in measuring the air volume expelled by steam from the interiors of pipes and heat-transfer surfaces. If the air sample to be anal-

yzed for dust content, however, is a fair one, taken from the main air stream and if the air flow speed through the sampling tube is maintained accurately at the same rate as in the main air stream, there will be no need of any quantitative measurement of the air sample by means of a gas meter. For instance, if the main stream air velocity is 1000 linear feet per minute and if the cross sectional area is 4 sq ft, 4000 cu ft per minute are passing by.

If the sampling tube is ¼ in. diameter (0.0003 sq ft) but has the same 1000 linear feet per minute speed as the main air stream, it will be passing 0.3 cu ft every minute. All that is necessary for assurance in this connection will be that the dust separating device will pass this much air at the pressure available. The sampling tube is provided with two auxiliary tubes which parallel the main sampling tube near its intake. One of these opens into the interior of the sampling tube while the other opens into the main airway.

The outer ends of these two auxiliary tubes are connected each with the other through a water gauge, and the suction pressure through the sampling tube is to be regulated so that this balancing gauge stands at zero.

How shall the difficulties encountered with sugar and similar dust filtering media, that may be unstable due to changing atmospheric conditions, be overcome?

There are available in the chemical laboratory supply market standard burned clay filter-crucibles. These are made of well mixed ingredients in uniform size, thickness and porosity. They are porous to the flow of gases. They can be provided with soft rubber gaskets around their rims and when these crucibles are placed over a sampling tube they do permit air flow through their walls while retaining the dust out of the air. The more dust they hold, of course, the more pressure will be required to force air through them, but if several pounds pressure as by a positive blower or by a piston type air pump are available, all necessary pressure can be maintained throughout many hours of heavy testing with one crucible.

In the practice followed in these laboratory tests for rating of an air cleaning device, a uniform volume of air is moved past the sampling tube for a timed period without any air cleaning unit in place. The crucible during this period receives its quota of the air and of the air borne dust. If dust, accumulating against the windward side of the crucible, tends to obstruct the air flow through the sampling tube the pressure gauge between the two auxiliary or balancing tubes will indicate lack of balance and the observer must correct this by increasing the suction on the leeward side of the crucible.

When testing an air cleaning device for rating, it is not practicable to wait around perhaps for weeks while the resistance builds up with the normal air dust. It is necessary, and assuredly permissible, to accelerate the process by introducing dust artificially. This dust need not be natural dust, because natural dust is not uniform but varies at different levels and at different city neighborhoods and in different cities. It is desirable therefore to use some standard dust which will be more or less representative of normal air impurities, which can be compounded anywhere and which shall serve as a part of the universal measuring stick of air cleaner efficiency, for general ventilation work.

After much discussion and experimentation, the dust of simple character which most nearly simulates actual city air and at the same time is universally obtainable appears to be one composed of 50 per cent by weight of common powdered lampblack, and 50 per cent by weight of bituminous coal ashes, which will pass a 200 mesh sieve. Any air cleaning device which will stop this aggregate will stop any kind of tangible iniquity which can be borne by an air stream.

The dust must of course not just be dumped into the air but must be fed in a uniform manner during the entire period of test and must simulate the procedure and concentrations of nature, so that if tests are being made with a wetted air cleaning device, for instance, the water will be given enough time to saturate each succeeding particle of dust. This time element is equally important for a viscous coated air cleaning device.

The dust, in a receptacle, tends to arch itself over any releasing orifice and when the arch eventually breaks there is an undesirable dust cloud. There are recorded in the TRANSACTIONS OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, several practical types of automatic dust mixing and feeding devices.

Since compressed air must be used in this proposed test why not employ it to deliver the dust?

An automatic dust feeding device was developed; one of several effective types, in which a stream of compressed air under constant pressure of several pounds through a very small orifice may dislodge the dust particles and may inject them into the main air stream, much as a similar stream of compressed air would be used to inject pulverized coal into the feeder of a combustion device. After a little practice the rate of flow of the compressed air can be regulated so as to consume any desired length of time in delivering any desired quantity of dust.

An air cleaning device may remove dust from air, but may not do it at an acceptable resistance to the passage of the main air stream. It is apparent that if any air cleaning device does arrest dust and if it holds the dust which it arrests, so delivering a continuously improved air stream as to dust content, the airways through the cleaning device tend eventually to clog up. From the moment when any non-automatic air cleaning device begins to receive dusty air it must begin to interpose increasing resistance to air flow with every minute that passes, until its time for reconditioning shall arrive.

There is no better way of indicating the resistance to air flow through a dust filter than by windward and leeward static pressure tubes, connected to a gauge which registers the pressure difference, just as did the tubes and gauge described for the sampling tube. If the ducts to windward and to leeward of the air cleaning device are not identical in size, then total pressure tubes, opening toward the direction of air flow, should be substituted for static tubes.

As a summary of the foregoing dissertation, with the methods and the instruments outlined, a reasonably careful and patient person may determine by cut and try methods for any air cleaning device, the best combination of the following factors:

1. Volume of air per unit of presentation area to which the apparatus is best adapted. This will be governed by the

resistance to air flow and by the ability of the device to arrest and to retain dust at that resistance-point.

2. Resistance to air flow will be governed by the amount of air forced through the device and by its ability at this speed to maintain a high arrestance of dust. The resistance to air flow of a non-automatic air cleaning device and probably the resistance of all air cleaning devices changes constantly from the moment of the beginning of dust arrestance to the moment when reconditioning commences.

   Such devices should be rated at the conditions of volume, resistance and arrestance in effect when the resistance is half way between its dustless minimum and its dustiest maximum.

3. Arrestance of dust will be established by the average conditions in effect when a uniform volume of air is being handled over the entire useful life of the device, this useful life being limited by the resistance to air flow.

Thus an air cleaning device might be rated at; 300 cfm per sq ft of face area at:

Resistance; clean 0.10 in.; resistance at end of reconditioning cycle 0.46 in.; average resistance 0.22 in.

Arrestance, average during test period of 10 hours, 94 per cent. This is obtained by the following formula:

$$\text{Arrestance} = 1 - \frac{G_1}{G_0}$$

in which G_1 is the dust caught by the sampling instrument to leeward of the air cleaning device and G_0 is the dust caught under the identical conditions with the air cleaning device removed.

No longer should an air cleaning device be selected merely because an efficiency of 97 per cent or 98 per cent is claimed. The method should be to select one proved to have a capacity something like the following:

> To arrest 94 per cent of standard dust at an average resistance to air flow not exceeding 0.22 in., from 300 cfm of air per square foot of face area. (Cell face, not necessarily filter face area.)

If the device is of the cell type select one which is guaranteed to hold this dust at the specified efficiency (meaning by efficiency in this case both arrestance and resistance) for the longest time. If the device is of the automatic type the rating would be in the same wording, with perhaps a greater volume of air per minute per square foot of face area.

The apparatus described and illustrated herein is substantially that of the Proposed Code for Testing and Rating Air Filters presented at the Semi-Annual Meeting, 1932, at Milwaukee. Modifications in detail of crucible mounting and preference for a vertical testing duct are the only changes in the physical set-up.

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World's Fair Attendance

The millionth visitor to the Century of Progress in Chicago was recorded during April, more than a month in advance of the Exposition's formal opening. An estimated attendance of 50,000,000 between June 1 and November 1, is considered conservative after an analysis of the attendance at 20 World's Fairs had been made.

The final stages of the work on the Century of Progress buildings and grounds indicates that everything will be in readiness on June 1, for the opening ceremonies. Exhibits are being rapidly installed and the fair will open with flowering landscapes, artistic color schemes and remarkable lighting effects.

The attention of engineers is focussed on the week of June 25-30 when a monster conclave is to be held by many of the National engineering organizations.

Lamme Medal for Edward Weston

The 1932 Lamme Medal of the *American Institute of Electrical Engineers* has been awarded to Dr. Edward Weston, Montclair, N. J., "for his achievements in the development of electrical apparatus, especially in connection with precision measuring instruments," and will be presented at the Summer Meeting of the Institute in Chicago, Ill., June 26 to 30, 1933.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Co., to provide for the award by the *Institute* of a gold medal (together with a bronze replica thereof) annually to a member of the *American Institute of Electrical Engineers,* "who has shown meritorious achievement in the development of electrical apparatus or machinery," and for the award of two such medals in some year if the accumulation from the funds warrants. A Committee composed of nine members of the *Institute* awards the medal.

Previous awards of the Lamme Medal of the *A. I. E. E.* were: Allen B. Field (1928), Rudolph E. Hellmund (1929), William J. Foster (1930) and Giuseppe Faccioli (1931).

Dr. Weston was a charter Member of the *American Institute of Electrical Engineers* and a member of the first Board of Directors. Having joined first as an Associate he was transferred in the same year (1884) to the grade of Member. He held offices in the Institute as Manager 1884-87, President 1888-89, and Vice-President 1889-91.

Detroit at Night

Delightful Detroit

Semi-Annual Meeting, June 22-24, 1933

THE Semi-Annual Meeting 1933 will be in charge of the Michigan Chapter and the Chairman of the General Arrangements Committee is L. L. McConachie. An active committee has been organized under the leadership of Mr. McConachie and his associates are H. E. Paetz, *Vice-Chairman;* J. F. Johnston, Jr., *Representative Western Michigan Chapter;* E. H. Clark, *Finance;* R. K. Milward, *Reception;* J. W. Snyder, *Registration;* Tom Brown, *Entertainment;* J. L. Fuller, *Transportation;* R. F. Connell, *Banquet;* G. D. Winans, *Publicity* and Wm. G. Boales, *Ladies.*

The dates selected for the Semi-Annual Meeting are June 22 to 24, and headquarters have been established at the Hotel Statler situated on Washington Boulevard and Grand Circus Park. The meeting will be held on Thursday, Friday and Saturday and each morning will be devoted to technical discussions while the afternoons and evenings have been reserved for golf, sightseeing inspection trips, banquet and other entertainment features.

Registration will commence at 8:30 on Thursday morning on the ballroom floor of the Hotel Statler. During the technical sessions, reports on a variety of subjects will be given and among the group selected by the Program Committee are Test Results on the Conductivity of Different Grades of Lumber; Heat Dissipation from Insulated Hot Water Pipes; Measurement of Air Flow through Grilles; Heat Output from Concealed Radiators; Air Stratification in Assembly Halls, as well as data from the A. S. H. V. E. Research Laboratory.

The program of entertainment should appeal to everyone who visits Detroit. The Semi-Annual Banquet and Dance will be held Friday evening and some unusual features are promised by R. F. Connell, Chairman of the Banquet Committee.

A special program for the ladies has been planned by W. G. Boales and it commences with a tea on Thursday afternoon. A luncheon at Ford's Dearborn Inn and a trip through the historical village that has been built near by is on the Friday program. Special trips to well-known plants are being planned for those who do not play golf. The golfers will have two afternoons for play; the first tournament is scheduled for Thursday afternoon. On Thursday evening a special entertainment and buffet supper will be served for men and ladies. Tom Brown has charge of the arrangements.

Reduced rates of fare have been authorized by the railroads, the round trip rate being fare and one-third. Meeting dates have been planned so that those members who are planning a combined

Skyline From Canadian Side

Fisher Building

vacation trip and a visit to the Century of Progress Exposition can conveniently attend the special Engineers Week Program arranged June 25 to 30, in Chicago.

With reduced railroad fares and low hotel rates, the cost of a three-day stay at the Semi-Annual Meeting will be inexpensive and the benefit to be derived will be worth many times the expense.

Detroit is accessible by rail, water and air. Fast train service from the east, south, west and north is furnished by the Michigan Central, Pennsylvania, B. & O., Grand Trunk, Wabash, Pere Marquette and Canadian Pacific systems. Palatial passenger steamers are in regular service between Detroit and Buffalo, Cleveland and Chicago. Airplane service is frequent from Cleveland, Chicago, Grand Rapids and Milwaukee.

Detroit is centrally located and good roads provide delightful and scenic routes for the motorists. The city is chiefly noted for its production of automobiles. Among its 3,000 plants however are some of the leading manufacturers of heating and ventilating apparatus, chemicals, electric refrigerators, air craft and office equipment.

The population of Detroit exceeds 2,000,000 and the city has an area of 139 square miles. It is located on the Detroit River which connects Lake Erie and Lake St. Clair. A splendid boulevard system has been developed and within the city are 50 public parks and two zoological gardens. Among the points of special interest that attract visitors to Detroit are Belle Isle, the Art Center, the Ambassador Bridge and Fleetway Tunnel to Canada, the Bell, Free Press, Fisher and General Motors Buildings, Masonic Temple, Historical Museum and the University of Detroit.

Members of the A. S. H. V. E. can spend a delightful three days in Detroit at the Semi-Annual Meeting June 22 to 24.

Program, Semi-Annual Meeting, 1933

Hotel Statler, Detroit, Mich., June 22-24
(Eastern Standard Time)

Wednesday, June 21

7:30 p. m. Council Meeting

Thursday, June 22

8:30 a. m. Registration
9:30 a. m. TECHNICAL SESSION
Greeting
Response by Pres. W. T. Jones
Four technical papers
Afternoon: Golf Tournament (Kickers Handicap)
Ladies' Tea
Evening: Buffet Supper and Dancing, Meadow Brook Country Club

Friday, June 23

9:30 a. m. TECHNICAL SESSION
Afternoon: Ladies' Luncheon
Sightseeing Trip
Golf Tournament (Research Cup)
7:30 p. m. Semi-Annual Banquet and Dance

Saturday, June 24

9:30 a. m. TECHNICAL SESSION

Washington Members Meet With President Jones

During a brief visit to Washington, on April 13, Pres. W. T. Jones had a luncheon conference at the University Club with 12 members from the District of Columbia. The members were especially interested in President Jones' outline of the value of Society membership and the present operation of Society business and research activities. In concluding his remarks, President Jones expressed the hope that a Chapter of the Society might soon be organized in the nation's capital.

The members present planned to investigate the possibilities of organizing a Chapter during the coming month and an active discussion was carried on by Messrs. Gardner, Urdahl, Coward, Backstrom, Beitzell and Tulloss.

Edward E. Ashley Opens Consulting Office

Edward E. Ashley announces the opening of an office at 10 East 40th St., New York, N. Y., for the general practice of mechanical, electrical and sanitary engineering. His services include air conditioning, elevators, Diesel and power plant equipment and modernization.

A. S. H. V. E. Booth at National Oil Burner Show

At the 10th Oil Burner Show to be held during the Annual Convention of the *American Oil Burner Association* at the Hotel Stevens, Chicago, Ill., June 12-16, the Illinois Chapter members of the Society will be in attendance at the A. S. H. V. E. Booth No. 102, where data resulting from research work at the Laboratory and cooperating institutions will be displayed.

According to an announcement issued by Harry F. Tapp, Executive Secretary of the *American Oil Burner Association*, business sessions will be held on the mornings of June 14 and 16. A Dealers Day Program has been arranged for the 14th and an Engineering Session will be held on the 16th. John H. McIlvaine, Evanston, will preside and the principal speakers will be: Samuel R. Lewis, Chicago, Consulting Engineer and Past President of A. S. H. V. E., whose talk will be on Air Conditioning; Prof. L. E. Seeley of the School of Engineering, Yale University, who will deliver a paper on Converting Gas Boilers to Oil; Hugh M. Robinson, whose subject is the Underwriter's Laboratory and Its Relation to the Oil Burner Industry; and W. F. Schroeder, who will discuss Selling and Installing Heavy Oil Burner Equipment.

Local Chapter Reports

Cleveland

March 10, 1933. The meeting was called to order at 8:00 p. m. in the Chapter Rooms of the *Cleveland Engineering Society* with an attendance of 34 members and guests.

The minutes of the January Meeting were read and approved and W. E. Stark of the Membership Committee moved that R. H. Wehrle be elected to membership in the Cleveland Chapter. E. S. Steffin was proposed for limited membership and both motions were carried.

The Membership Committee report included an announcement of the action taken by the Board of Governors for a revision of the annual chapter dues. This action is to be voted on by members upon receipt of the proposed amendment, which will be mailed to the membership.

Pres. R. G. Davis appointed C. A. Wheeler and E. J. Vermere as an Auditing Committee.

A general discussion of the proposed combined meeting between the Cleveland and Pittsburgh Chapters brought out the fact that the Society's Semi-Annual Meeting was to be held in Detroit at a time very close to the date proposed for the Joint Meeting. It was suggested by Philip Cohen that further correspondence with Pittsburgh would be advisable regarding a later date.

J. C. Miles, chairman of the Program Committee, introduced the speaker of the evening, H. B. Matzen, whose subject and illustrated talk covered the combined heating and cooling installation made in the Reynolds Arcade Office Building at Rochester, N. Y. Mr. Matzen gave a splendid description of the system designed for various parts of the new building and told of the particular arrangements made for meeting winter and summer requirements.

A general discussion followed and, upon a motion of appreciation and thanks presented by C. F. Eveleth, the meeting was adjourned at 10 p. m.

Illinois

April 10, 1933. Forty-eight members and guests of the Illinois Chapter gathered at the Hotel Sherman, Chicago, Ill., for a dinner and meeting with Pres. J. H. O'Brien presiding.

Secy. J. J. Hayes called the attention of the members to a Joint Chapter Meeting of the Wisconsin, Minnesota and Illinois Chapters, to be held at La Crosse, Wis., April 25.

Samuel R. Lewis introduced one of the Chapter's distinguished visitors, Thornton Lewis, a past president of the Society, who spoke briefly of Society affairs and urged the hearty cooperation of every member with the A. S. H. V. E. Officers and emphasized the importance of attending the Semi-Annual Meeting in Detroit, Mich., June 22-24.

The Illinois Chapter was honored by the presence of W. T. Jones, President of the Society, who was presented by John Howatt. In presenting Mr. Jones, Mr. Howatt spoke about the President's many years of activity and his devoted service on A. S. H. V. E. affairs.

The members then listened to one of the most inspiring two-fisted talks given in a Chapter meeting in many months on The Status Quo of Our Society. President Jones stressed the point that the Society's problem is exactly like a business problem. It must be expected that members will drop out in hard times. The situation must be met with a reduced budget and reduced activities, at the same time maintaining a suitable balance between scientific and business activities.

President Jones continued with a brief outline of just what each member receives for his annual dues in the Society. He mentioned first the 40 per cent which goes for research and named just a few of the valuable benefits received from the Research Laboratory. He called attention to The Guide, the monthly Journal of the Society, the Transactions, and concluded his list by mentioning the intangible value and privilege of attending the Annual and Semi-Annual Meetings, with the resulting contacts and friendships, values immeasurable in dollars.

President Jones devoted several minutes to a few additional remarks concerning the Research activities under the chairmanship of Prof. G. L. Larson, calling attention to the benefits derived from our cooperative agreements with prominent universities.

Mr. Jones concluded his talk by urging each member to actively cooperate with the Society Officers, to speed up the membership work, to attend the Summer Meeting at Detroit in June and made a final plea to guard the heritage given each one by membership in the A. S. H. V. E.

President O'Brien then introduced Capt. J. W. Gorby, of the Speakers' Bureau of the Century of Progress, who spoke on Highlights in the Development of the Century of Progress. His excellent talk was illustrated with numerous slides in color.

W. O. Axtel, engineer from the Applied Science and Industry Division, of the Century of Progress, was present to answer engineering questions of the Chapter members. His brief talk covered such subjects as ventilation, sanitation, water supply, fire protection, electrical layout and other technical problems.

An estimate of the probable attendance at the Exposition is placed at 50,000,000 or an average of 350,000 per day.

Each A. S. H. V. E. member should note that Engineers' Week at the Century of Progress is June 25-July 1, the week immediately following the Society's Semi-Annual Meeting in Detroit.

Kansas City

April 6, 1933. The Kansas City Chapter met at the Newbern Hotel for 6:00 o'clock dinner, the regular meeting date having been changed to accommodate the speaker, T. A. Novotney, of Johnstown, Pa. Mr. Novotney's subject was the Engineer's Approach to the Design of Convectors and brought out the relationship between the construction and the results obtained. It was an interesting, instructive and worthwhile talk according to the report of Secretary D. D. Zink.

The Chapter also heard some facts about fans, motors and controls which were given by Carl Clegg and W. A. Wirene.

Jack Squire, a local electrical contractor, spoke briefly on behalf of the committee on the renovating campaign.

The Nominating Committee was announced by Pres. W. A. Russell with the following members: Carl Clegg, *Chairman*; J. H. Kitchen, J. M. Arthur, F. F. Dodds and E. K. Campbell.

The Membership Committee, with Mr. Clegg as chairman, reported one application for membership. The new application forms sent out by Headquarters Office were discussed briefly and the hope was expressed that the members may have use for many of them.

The Kansas City Chapter feels that it has had a most successful season and that the Educational Program put on by members of the Chapter has been a worthwhile feature of the year's work.

Massachusetts

April 10, 1933. The regular monthly meeting of the Massachusetts Chapter was held at noon in Durkin & Park's private room at 16 Haywood Place, Boston.

The Nominating Committee, consisting of J. W. Brinton, T. F. McCoy and G. B. Gerrish, brought in the names of L. A. Bris-

sette and E. Q. Cole to be balloted upon as new members of the Board of Governors to serve for three years.

Secy. Leslie Clough was instructed by Mr. McCoy, who presided, to write to Pres. F. R. Ellis, who is convalescing from a recent operation, and extend the best wishes of the Chapter for a speedy return to normal health.

An announcement was read relating to the Semi-Annual Meeting of the Society to be held in Detroit, June 22-24, at the Hotel Statler, with the Michigan Chapter as hosts.

The 45 members and friends present were intensely interested in an address by H. B. Gill, Superintendent of the State Prison Colony at Norfolk, Mass., who was introduced by J. S. Webb of the Papers and Meetings Committee.

Mr. Gill told of the methods of housing prisoners and of the reasons for arrest over a period dating from pre-Colonial days in England to the present time. He stressed the advisability of the prison colony, where most of the men incarcerated are treated well and allowed privileges found in the ordinary walks of life, although hemmed into a colony by prison walls.

Mr. Gill cited many interesting and amusing conclusions from his contact with prisoners and said that the manner of handling prisoners after conviction was perfected in a far lesser degree than the manner of arrest and trial.

In keeping with the recently inaugurated procedure, Mr. Cole called the roll of attending members and was again congratulated on his attendance efforts.

Michigan

April 6, 1933. Twenty-three members and guests attended a meeting held at the Detroit-Leland Hotel.

Pres. L. L. McConachie asked Messrs. Milward and Brown to obtain information regarding the costs of green fees and dinners at various golf clubs for the May meeting, and to report to the Board of Governors.

J. F. McIntire spoke regarding the Society's Semi-Annual Meeting to be held in Detroit and presented a brief resumé of the work already accomplished.

National President W. T. Jones, Boston, was then introduced by President McConachie and gave a very fine talk on the activities of the Society and its financial condition.

A lengthy discussion followed, after which the members gave Mr. Jones a rising vote of thanks.

New York

April 17, 1933. At the April Meeting of the New York Chapter, held in the Building Trades Club, Acting President Harold Alt appointed C. R. Hiers, H. W. Fiedler and H. G. Meinke as tellers of election. Secy. T. W. Reynolds received and read their report, stating that 57 ballots had been cast all in favor of the officers as presented by the Nominating Committee at the March meeting of the Chapter.

The Secretary read a letter from A. V. Hutchinson, Secretary of the Society, regarding the Semi-Annual Meeting of the Society to be held in Detroit on June 22-24, 1933.

Attention was also called to the new form of membership application blank now being used.

Mr. Alt, newly elected president, made an announcement regarding the condition of F. E. W. Beebe, for many years treasurer of the New York Chapter, who is now convalescing in a Newark, N. J., hospital from injuries suffered in a fall.

Messrs. Fiedler and Hiers, of the Entertainment Committee, spoke in regard to the May Party to be held at Mecca Temple.

President Alt announced that Perry West would speak briefly about his constructive plan to solve economic problems of the present era. Mr. West reviewed what is being done by the government and others to restore business activity, saying that everything that had been done was for the long pull and of no immediate help. He spoke of the fifteen million unemployed and said that unless something is done and done quickly he felt that we are nearing a social and economic breakdown. Mr. West suggested that the president appoint a committee of three, consisting of one older and experienced engineer, a business genius and a young live wire, to report to Congress. This resolution was accepted by the Chapter.

The speakers of the evening were A. L. Jaros, consulting engineer, and T. N. Adlam, mechanical engineer, formerly associated with A. H. Barker of London. They discussed the theory and applications of radiant heating in America and their remarks were supplemented with moving pictures of installations.

In spite of the disagreeable weather, 52 members and guests who had assembled for dinner and 10 additional members were present and followed the speakers' remarks with the greatest interest yet shown, until the meeting closed at 11:00 p. m.

March 20, 1933. A meeting of the New York Chapter was held at the Building Trades Club with 81 members and guests present at dinner and an additional attendance of 39 at the meeting which followed.

H. G. Issertell, having got all the breaks from an automobile accident in January, made his first public appearance again at this meeting and his return was welcomed by the acting president.

Russell Donnelly, chairman of the Nominating Committee, reported the following nominations:

For President—H. L. Alt.

For Vice-President—H. W. Fiedler.

For Secretary—T. W. Reynolds.

For Treasurer—W. M. Heebner.

For Board of Governors—A. F. Hinrichsen, S. A. Patorno and W. W. Timmis.

A. J. Offner, chairman of a special committee appointed to review pending legislation relating to school ventilation, recommended that a letter be drafted condemning Senate and Assembly Bills known as the Mastick and Pratt Bills and that it be forwarded to the senators in charge of the bills. The motion was carried and each member of the Chapter was urged to communicate with his legislative representatives.

The subject of the meeting, A Quantitative Survey of Productive Economy, was introduced by F. L. Ackerman, architect, and Bassett Jones, consulting engineer gave an interesting illustrated talk. Statistics and higher mathematics were presented in volume together with charts and curves that curved in ways which predict dire disaster for all those who survive until the year 1950. The subject should have been labelled The Decline and Fall of the Business Empire, according to Secy. T. W. Reynolds. The meeting closed at 11:00 p. m. but discussions continued until 11:30 p. m.

Western New York

April 3, 1933. The April meeting of the Western New York Chapter, held as usual at Gandy's, broke all attendance records for the year when approximately 40 members and guests turned out to hear Pres. W. T. Jones, Boston.

A motion was made and carried to continue the Chapter's affiliation with the *Buffalo Engineering Society* under the present arrangements.

Pres. D. J. Mahoney then introduced the president of the A. S. H. V. E., Mr. Jones, who gave an inspiring message under the title of The Status Quo of Engineering. President Jones presented a very clear picture of what the Society is doing and how the dues are allocated, proving conclusively that every member receives more by far than the actual cost of membership. If there were any doubts in the minds of President Jones' listeners as to their duty to uphold the industry and continue their allegiance to the Society, his presentation of conditions certainly dispelled them. It was very encouraging to hear the President's message and the Chapter will carry on with a better understanding and spirit, says Secy. W. E. Voisinet in his report of the meeting.

Ontario

April 4, 1933. At the regular meeting held at the Prince George Hotel at 6:00 p. m. 33 members and guests were present. At this meeting the Chapter had the pleasure of hearing W. T. Jones, Boston, President of the A. S. H. V. E., who spoke on the activities of the Society and what the Society means to every member.

Following a delightful dinner, M. B. Watson reported on the Ontario Chapter's 1933 Award to the student at the University of Toronto, who wrote the best thesis on heating and ventilating. The Chapter selected the paper of T. R. Sykes, whose subject was Heat Distribution in Warm Air Heating Systems, and Mr. Sykes will receive the award.

There were two theses written, the second being on Air Conditioning by Mr. Gibson. Due to the excellent contents of both papers, the Chapter will present Mr. Gibson with a copy of THE A. S. H. V. E. GUIDE 1933 in recognition of his work on this subject.

The annual dues will be reduced from $5.00 to $3.00 per year, as a temporary measure to extend over a period of two years.

H. H. Angus reported on the action of the Nominating Committee for the coming year as follows:

For President—W. P. Boddington.

For Vice-President—W. R. Blackhall.

For Secretary-Treasurer—H. R. Roth.

For Board of Governors—M. W. Shears, J. S. Paterson and Thomas McDonald.

Members were urged to be present at the Semi-Annual Meeting of the Society to be held at the Hotel Statler, Detroit, June 22-24.

Philadelphia

April 13, 1933. The April meeting of the Philadelphia Chapter, held at the Engineers Club, began with dinner at 6:45 p. m. A feature of this occasion was the Presidents' Table, at which were seated W. T. Jones, President of the Society, C. V. Haynes, 1st Vice-President, A. V. Hutchinson, Secretary, M. F. Blankin, President of the Chapter, W. P. Culbert, Vice-President, and 11 Past Presidents of the Chapter.

Following dinner, the members adjourned to the Club Auditorium where President Blankin opened the meeting.

The minutes of the March Meeting were read by Secy. W. R. Eichberg and approved as was the report of Treas. J. H. Hucker.

President Blankin requested each of the Past Presidents of the Chapter to stand and stated that it was his desire to see them organized into an Advisory Council for the Chapter. He appointed a committee to perfect such an organization with R. C. Bolsinger as chairman and F. D. Mensing and L. C. Davidson serving with him.

W. T. Jones, President of the A. S. H. V. E., was introduced to the members by Vice-Pres. C. V. Haynes and gave a most interesting address covering the value of membership in the Society. During his talk he paid tribute to the cooperation of the men at the Research Laboratory at Pittsburgh and to the Secretary and his staff at the Headquarters Office. By his friendly personality, President Jones won the entire membership and the hope was expressed that he might visit the Chapter again.

R. J. Thompson, refrigeration engineer, presented a paper on Freon with demonstrations of its use as a refrigerant, which was both educational and interesting. The discussion following Mr. Thompson's paper brought out facts in connection with the uses of Freon and was taken part in by a large number of the members.

The chairman of the Meetings Committee outlined the program for the May Meeting and announced that President Blankin had requested that arrangements be made for a Golf Meeting to be held at a later date, possibly in June.

As President Blankin had to leave before the session was over, the meeting was closed by Vice-President Culbert.

Pittsburgh

April 12, 1933. The regular monthly meeting of the Pittsburgh Chapter was held in the Auditorium of the United States Bureau of Mines, Pittsburgh, Pa. There were 45 members and guests present when Pres. G. S. McEllroy called the meeting to order at 7:45 p. m. Among them were W. T. Jones, Boston, President of the A. S. H. V. E., and H. P. Gant, of Philadelphia, a Past President of the Society. Secy. J. L. Blackshaw wrote the minutes.

The minutes of the meeting held March 13, 1933, were read and approved. H. B. Orr, Treasurer, gave his monthly report and answered questions asked by E. C. Evans concerning the Chapter money tied up in the closed Diamond National Bank. L. B. Pittock, Chairman of the Program-Publicity Committee, explained that the main part of the program for the May 8 meeting would consist of an informal debate on Hot Water versus Steam for Heating, with J. E. McLean and P. A. Edwards speaking in favor of hot water, and F. J. Firsching and T. F. Rockwell presenting the case for steam. It is planned that the audience will give its views.

Mr. Pittock also reported on the proposed joint meeting with the Cleveland Chapter, saying that the idea had been enthusiastically accepted and that it appeared that about 70 men from the two cities might meet in Youngstown, Ohio, for a technical session, golf, and visits to several of Youngstown's industrial plants. At the next meeting, Mr. Pittock expects to be able to give the definite date for this trip, which will probably be put forward from June to sometime in September.

President McEllroy pleaded that members become active in bringing in new members for the Society. He announced that the quota of new members for the Pittsburgh Chapter in 1933 had been set at 10 per cent of its present membership, which necessitated that the Chapter obtain 7 new members during the year. He also asked that members pay their delinquent and current dues. The Secretary read and discussed a letter received from Headquarters Office concerning the new application form of the Society. This form is easily used and should result in a much speedier election of applicants than was possible with the old form which required much more correspondence. The question of national dues was also brought up and it was made clear that prospective members this year need pay no initiation fee.

All members were urged to attend the 1933 Semi-Annual Meeting of the Society to be held in Detroit, June 22 to 24. The date selected will allow them to go to the Meeting and then continue on to the World's Fair in Chicago and be there during Engineers' Week, June 26 to July 1.

Percy Nicholls, Fuels Engineer for the United States Bureau of Mines, invited all who would be interested to visit his fuels laboratory in the building at the close of the meeting to inspect an ultra-refined boiler test which he was conducting.

President McEllroy announced that the National Building Owners' and Managers' Convention would be held in Pittsburgh in June. Mr. Evans moved, seconded by Mr. Edwards and carried, that President McEllroy appoint a committee to represent the Pittsburgh Chapter at this Convention, and announce its personnel at the May meeting.

F. C. McIntosh presented the Chapter's guest and speaker, W. T. Jones, of Boston, President of THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, who spoke on "The Status Quo of Engineering." President Jones gave a spirited and inspiring talk on the many phases of A. S. H. V. E. work and showed the relation existing between an engineering profession and that profession's society. He not only pointed out the many advantages gained through membership in an ethical society through its activities, publications, research work, meetings, etc., but proved definitely that a member of the A. S. H. V. E. got more from the Society in its Transactions, Guide, and Journal alone than he paid for in dues, not to mention the personal contacts. President Jones lauded the Society for maintaining

its own Research Laboratory, it being the only technical society to have one.

President Jones answered many questions concerning the Society, which were put by the members in the course of enthusiastic discussion following his talk. At its close, Mr. Jones was tendered a rising vote of thanks.

The meeting was adjourned at 9:30 p. m.

March 13, 1933. The regular monthly meeting of the Pittsburgh Chapter was held in the Auditorium of the U. S. Bureau of Mines when Pres. G. S. McEllroy presided and Secy. J. L. Blackshaw wrote the minutes.

L. B. Pittock, chairman of the Program-Publicity Committee, reported that the President of the Society, W. T. Jones, Boston, would be the Chapter's guest and speaker at the April 12 meeting, scheduled to be held at the Bureau of Mines.

President McEllroy stated that in accordance with the Society's aim to increase its membership by 10 per cent, it would be necessary that the Pittsburgh Chapter obtain seven new members during the year. He also requested members to pay their delinquent and current dues.

Mr. Pittock brought up the question of having either a later spring or early fall Joint Meeting with the Cleveland Chapter at some intermediate point such as Youngstown or Akron, where industrial plants could be inspected and golf enjoyed. The members received the idea with enthusiasm, feeling that such a meeting would be very fine for both Chapters, and Mr. Pittock was instructed to correspond with the Cleveland Chapter and work up tentative plans for such a meeting.

President McEllroy next presented the Chapter's guest, Dr. C. E. Skinner, former Director of Research of the Westinghouse Electric & Manufacturing Co., Pittsburgh, who talked on Electrical Pioneering. Dr. Skinner gave a review of the electrical industry, filled with anecdotes, and it was evident that he had grown up with commercial electrical developments and had a wealth of personal experience in the field.

The audience showed its appreciation of Dr. Skinner's talk by its enthusiastic discussion. Percy Nicholls, Supervisory Fuel Engineer, of the U. S. Bureau of Mines, also told some interesting stories of electrical pioneering in England where he had been connected with the industry.

After a rising vote of thanks had been tendered the speaker, the meeting was adjourned at 9:30 p. m.

Southern California

March 14, 1933. The Los Angeles Chapter, having been advised that P. D. Close was planning on making Southern California his home for the next few months, arranged a rocking celebration in his honor in the form of a nice, made-to-order EARTHQUAKE. Mr. Close, to show his disdain of Mother Nature, was a guest of honor at a luncheon three days after said tremble and met with 91 members and friends for the second of the series of inter-related lectures on the subject of Air Conditioning.

The paper for March was on Fans: Design, Characteristics and Performance and was presented by D. T. Robbins. The speaker gave the interested audience a very complete word picture of the four general types of fans and the particular field of application of each type.

After Mr. Robbins had presented the theories of the subject, W. H. C. Ness and A. G. Orear each gave a five minute talk on the subject of forward and backward curve applications respectively.

It was announced that at the next meeting, the subject to be presented would be Humidifiers and Dehumidifiers with Mr. Robbins again as the speaker.

Secy. E. H. Kendall, who signs his report, "Shockingly yours," states that none of the Chapter members was injured in the earthquake, although many were in Long Beach. The majority of destruction was suffered by Class "C" Structures and in "Gingerbread" Facings, which were not properly tied in. He believes that reports were very much exaggerated by the sensational press. The facts are: that deaths numbered 118; seriously injured 300 and the total property damage was less than one per cent of the total in the quake zone. Secy. Kendall reports that just five days after the shimmy, there was little to remind Southern California inhabitants that their utopian spot had suffered materially or that the old spot is anything but the end of the rainbow for them.

St. Louis

April 5, 1933. The April Meeting of the St. Louis Chapter was held at the home of the *Heating and Piping Contractors St. Louis Association* and was preceded by a buffet lunch in the Rathskeller.

J. W. Cooper, chairman of the Entertainment Committee, reported that the June meeting will be held at one of the Country Clubs and will be in the nature of a Golf, Bridge and Dinner Dance Party.

A motion was made by P. W. Sodemann and seconded by E. A. White that the May meeting be held at the Home of the *Heating & Piping Contractors Association* and this was carried.

The treasurer, A. L. Walters, indicated a balance on hand in the amount of $362.13.

Mr. Sodemann, chairman of the Membership Committee, read a limited chapter membership application for the St. Louis Chapter received from Walter Warren.

Pres. C. A. Pickett then introduced the speaker of the evening, T. A. Novotney, Johnstown, Pa., who presented a paper on Convection Heaters, which recorded the romance, trials and tribulations of research engineers. Mr. Novotney's talk proved very interesting and educational to the 25 members and guests present.

President Pickett thanked the speaker in behalf of the Chapter for his visit to St. Louis and his able presentation of the subject.

Western Michigan

February 13, 1933. The Western Michigan Chapter considerably widened its scope of activity in February, when it met with the Peninsula Section of the *A. S. M. E.* in a joint meeting in the English Room of the Rowe Hotel, Grand Rapids.

After the jovial fellowship over a dinner, which is always present among such gentlemen, stimulated with a little singing and entertainment, the meeting was called to order by Pres. D. L. Taze, who turned the program over to President Waring, of the local section of the *A. S. M. E.*

The speaker of the evening was C. F. Hirshfeld, Chief of the Research Department of the Detroit Edison Co., whose subject was The Field of Professional Development. Having been a member of the Council of the four founder societies on Professional Development, his expression of this thought came from a considerable amount of study and experience. Contending that the professional engineer does not command the respect and authority that his long years of preparation and activity warrant, Mr. Hirshfeld's contribution offers constructive plans for molding the profession to a higher plane within a generation. O. D. Marshall writes that an interesting discussion followed this presentation before adjournment.

Wisconsin

March 20, 1933. Pres. V. A. Berghoefer opened the meeting in the clubroom of the Hotel Pfister, Milwaukee, and the minutes of the February meeting were read and approved. A letter from Headquarters Office announcing the Semi-Annual Meeting to be held at Detroit, June 22-24, was read.

A letter from N. Downey, of the Trane Co., stated that the Minnesota Chapter had accepted an invitation to visit LaCrosse on April 25 for a plant inspection trip, an afternoon of golf and

a meeting in the evening, at which Prof. G. L. Larson and Prof. F. B. Rowley would be the featured speakers. N. D. Adams, in charge of the arrangements for Minnesota Chapter extended invitations to the Wisconsin and Illinois Chapters to make this a combined Chapter meeting for the month of April. A motion was made that Secy. C. H. Randolph write Mr. Downey suggesting that the meeting be held on Monday, rather than Tuesday.

A report of the Special Finance Committee was read and the following resolutions passed:

Resolved, that the date of collection of dues be changed so that they are payable in advance rather than at the end of the year as at present, also be it

Resolved, that at the discretion of the committee an offer to cancel back chapter obligations for members in good standing can be made based on their paying their 1933 dues within thirty days of written notice; and be it further

Resolved, that when the proper cause exists in the committee's minds an extension of time can be made to worthy members providing they express a willingness to pay the dues when able and also express the desire to remain affiliated with the Chapter.

The secretary was instructed to write Professor Larson at the University of Wisconsin regarding the payment of dues of the Madison members.

E. A. Jones discussed Bill No. 386A, now before the legislature, and a motion was made, seconded and passed unanimously that the Wisconsin Chapter go on record as being against such legislation. A second resolution was made and seconded that the secretary prepare and send to all Wisconsin utilities a letter stating quite definitely the basis of the Chapter's action in regard to Bill No. 386A.

The Japanese film received from the *A. S. M. E.* on Air Motion and Sound Propagation was then shown, after which the meeting was adjourned.

February 20, 1933. A dinner and meeting of the Wisconsin Chapter was held in the Mirror Room of the Hotel Pfister, when R. F. Norris, of the Burgess Laboratories, Madison, discussed Acoustical Treatment of Mechanical Installation and Ventilating Systems.

Mr. Norris gave the Chapter and their guests a very interesting evening on the question of sound, just what it is, how to eliminate it, and how to measure it. His talk was accompanied with slides, noise producing equipment and sound measuring equipment. Those present began to realize the reason back of so many troubles which they had experienced in the past. One point which seemed to be outstanding with interest was the way in which sound multiplies. The question came up as to what makes twice as much noise as one pig and much to the discomfort of those present who brightly answered, "Two pigs," it turned out that it actually takes ten pigs.

The meeting was very well attended and after considerable questioning, Mr. Norris found himself pigeon-holed in the lobby. Had it not been necessary for him to make a train, the meeting might undoubtedly have run far into the night.

F. E. Beebe Recovering from Injuries

The many friends of F. E. W. Beebe of Johnson Service Co., New York, will be glad to know that he is making a good recovery from severe injuries sustained in a fall, while inspecting an installation at Newark, N. J. For several weeks he has been confined in the Presbyterian Hospital, Newark, and he has been happy that so many of his friends have called on him and thereby made his convalescence more pleasant.

John Fritz Medal Awarded

Announcement has been made of the award of the John Fritz Medal to Daniel C. Jackling for notable industrial achievement in initiating mass production of copper from lower grade ores through the application of engineering principles.

The John Fritz Medal is awarded by the four Founder Engineering Societies, the *A. S. C. E., A. I. M. E., A. S. M. E.* and *A. I. E. E.* in memory of John Fritz, one of America's great pioneers in the iron and steel industries. The medal is of gold and it is awarded for notable scientific or industrial achievement.

Air Conditioning Convention Planned

Pres. L. H. Polderman, of the A. S. H. V. E. Southern California Chapter, has announced that plans are being made for an Air Conditioning Convention and Display of Equipment to be held in Los Angeles as a result of cooperative effort by the Chapter, the University of Southern California in L. A., the L. A. Chamber of Commerce and the public utilities companies.

The Convention is scheduled to be held at the University of Southern California in Los Angeles on May 23, when the program will include a technical session in the afternoon, a dinner and an evening session. Arrangements are being completed to secure eminent speakers for the occasion.

In addition, during the week of May 22-29, a complete line of heating, ventilating and air conditioning equipment will be exhibited at the Los Angeles Chamber of Commerce Building.

The opening address at the Convention will be made by P. D. Close, who will give a resumé of the Heating, Ventilating and Air Conditioning Industry.

Much enthusiasm has been evidenced and a successful meeting is anticipated.

Home Building Conference

A new and optimistic outlook has caused 30 leaders in the construction and allied trades to call a National Conference on the Renewal of Home Building to meet at the Congress Hotel, Chicago, Ill., May 9 and 10.

The program is being planned with the purpose of reassuring the public on this subject.

The preliminary announcement states that William F. Stevenson, president of the Federal Home Loan Bank Board; James S. Taylor, chief of the division of building and housing, Bureau of Standards, United States Department of Commerce; Dr. L. C. Gray, Bureau of Land Economics, United States Department of Agriculture and H. Vandervoort Walsh, professor of Architecture at Columbia University, New York City, will be among the speakers.

The following are serving on the Committee on Arrangements: George W. Dulany, Jr., American Forest Products Industries; R. W. Starrett, President, Starrett Building Co.; H. J. Thorkelson, Kohler Co.; Alfred K. Stern, Julius Rosenwald Fund and Chairman of the Illinois Housing Commission; William Zelosky, Wm. Zelosky Co.; John R. Fugard, President, *Illinois Society of Architects;* Daniel H. Burnham, Chairman, Chicago Regional Zoning Commission; Ralph P. Stoddard, Manager, *Brick Manufacturers Association of America;* Paul B. Belden, President, *American Face Brick Association;* A. P. Haake, Managing Director, *National Association of Furniture Manufacturers, Inc.;* Russell Creviston, Crane Co.; George Meyercord, President, The Vitrolite Co.; E. J. Mehren, President, *Portland Cement Association;* Herbert U. Nelson, Executive Secretary, *National Association of Real Estate Boards;* Chas. K. Foster, Executive Vice-President, American Radiator Co.; Edward A. MacDougall, President, Queensboro Corp.; N. Max Dunning, Advisor on Architecture to the Reconstruction Finance Corporation, Chicago; Holman D. Pettibone, President, Chicago Title & Trust Co.; N. G. Symonds, Vice-President, Westinghouse Elec. & Mfg. Co.; J. Soule Warterfield, Vice-President, Starrett Building Co.; Percy Wilson, Chairman, Home Builders & Subdividers Division, The Chicago Real Estate Board; John H. Millar, Millar's Housing Letter; C. J. Bassler, President, Air Conditioning Corp.

The conference will be free of cost; there will be no registration and admission will be by card which can be secured from Secy. H. A. Guthrie, Rm. 1041, 310 So. Michigan Ave., Chicago.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 14 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly **of any whose eligibility for membership is in any way questioned.**

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by May 15, 1933, these candidates will be balloted upon by the Council. Those **elected to membership will be notified by the Secretary immediately after election.**

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
CHAPIN, C. GRAHAM, Treas., Hopson & Chapin Co., New London, Conn.	W. T. Hopson	W. B. Hoyt
	T. E. Crone	Wm. Forsberg
FINERAN, EDWARD VINCENT, Laboratory Engr., Washington Gas Light Co., Washington, D. C.	L. S. Ourusoff	D. P. Allen (*Non-Member*)
	W. K. MacMahon	
HANLEY, THOMAS F., JR., Pres., Hanley & Co., Chicago, Ill.	John Howatt	H. R. Linn
	R. M. Getschow	John Aeberly
HANSEN, C. J., Graduate Student, Agric. & Mech. College of Texas, College Station, Tex.	W. H. Badgett	V. M. Faires—(*A. S. M. E.*)
	E. G. Smith	R. M. Wingren—(*A. S. M. E.*)
HOLT, JAMES, Asst. Prof. of Heat Engrg., Mass. Inst. of Tech., Cambridge, Mass.	W. T. Jones	C. R. Swaney
	G. B. Bailey	Alfred Abboud
JENNEY, HUGH B., Sales Mgr., Dominion Boiler & Radiator Co., Toronto, Ont., Canada.	W. R. Blackhall	W. T. Ward
	H. H. Angus	Wm. Philip
LEGLER, FREDERICK W., Mgr., Mpls. Retail Branch, Waterman-Waterbury Co., Minneapolis, Minn.	F. B. Rowley	C. E. Lewis
	H. M. Betts	F. G. Sedgwick—(*Non-Member*)
LEIGH, ROBERT LAWTON, Student, Michigan State College, E. Lansing, Mich.	J. H. Van Alsburg	H. B. Dirks (*Non-Member*)
	D. L. Taze	L. G. Miller (*Non-Member*)
MACDONALD, EVERETT A., Br. Mgr., Spencer Heater Co., Boston, Mass.	J. S. Webb	L. A. Brissette
	R. S. Franklin	H. B. Wiegner
MEINKE, HOWARD G., Asst. Engr., N. Y. Edison Co., New York, N. Y.	H. W. Fiedler	A. V. Hutchinson
	R. W. Cumming	J. O. Lennon
REYNOLDS, JACK A., Graduate Student, Agric. & Mech. College of Texas, College Station, Tex.	W. H. Badgett	C. W. Crawford—(*A. S. M. E.*)
	E. G. Smith	V. M. Faires—(*A. S. M. E.*)
STROBL, J. A., Est. and Engr., Kirk & Blum Mfg. Co., Cincinnati, Ohio.	R. E. Peck	R. W. Sigmund
	H. E. Sproull	C. J. Kiefer
STRUNIN, JAY, Supt. and Est., Strunin Plbg. & Htg. Co., Inc., New York, N. Y.	W. S. L. Cleverdon—(*Non-Member*)	C. E. Gus—(*Non-Member*)
	M. C. Giannini—(*Non-Member*)	C. P. Bliss—(*A. S. M. E.*)
VANDERHOOF, A. L., Pres., A. L. Vanderhoof, Inc., Cleveland, Ohio.	C. F. Eveleth	E. J. Vermere
	W. E. Stark	C. A. Wheeler

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

BARNUM, W. E., JR., York Ice Machinery Corp., Los Angeles, Calif. (*Advancement*)

BREITENBACH, GEORGE C., The Trane Co., Philadelphia, Pa. (*Advancement*)

EISS, ROBERT M., Eggertsville, N. Y. (*Advancement*)

GILLING, WILLIAM F., Asst. Mgr., American Radiator Co., Boston, Mass. (*Advancement*)

JOHNSON, CLARENCE W., Dist. Mgr., Canadian Sirocco Co., Ltd., Montreal, Que. (*Advancement*)

MCLARNEY, HARRY W., Sales Engr., Air Cond. Div., Union Electric Light & Power Co., St. Louis, Mo.

NEEDLER, J. H., Engr., Phillips Getschow Co., Chicago, Ill.

QUEER, ELMER ROY, Instr. in Engrg. Research, Penn. State College, State College, Pa.

ROCKWELL, THEODORE F., Instr. in Htg. & Vtg., Carnegie Inst. of Technology, Pittsburgh, Pa. (*Advancement*)

RODENHEISER, GEORGE B., Instructor, David Ranken Jr. School, St. Louis, Mo.

SAUNDERS, LAURENCE PEMBROKE, Director of Engrg., Harrison Radiator Corp., Lockport, N. Y.

SHERMAN, RALPH A., Fuel Engr., Battelle Memorial Inst., Columbus, Ohio.

VOGT, JOSEPH B., Htg. Engr., N. Y. State Dept. of Public Works, Albany, N. Y. (*Advancement*)

WILKINSON, FARLEY JAMES, Engr., Montgomery Ward & Co., Chicago, Ill.

ASSOCIATES

DAVENPORT, R. F., Furnace Sales Mgr., Canada Foundries & Forgings, Ltd., Brockville, Ont., Canada.

EDWARDS, DON J., Vice-Pres., General Heat & Appliance Co., Boston, Mass.

GODFREY, PAUL S., Mgr., Iron Fireman of Milwaukee, Inc., Milwaukee, Wis.

HANLEY, EDWARD V., Pres., S. V. Hanley Co., Milwaukee, Wis.

HAYES, JOHN J., Office Mgr., Auburn Stoker Sales Corp., Chicago, Ill.

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STEVENS, JOHN M., Plbg. & Htg. Contractor, Philadelphia, Pa.

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FERNALD, HENRY B., JR., Student, New York University, New York, N. Y.

FERRERO, HENRY J., Student, New York University, New York, N. Y.

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HAIGNEY, JOHN E., Student, New York University, New York, N. Y.

HAMBURGER, FRED. G., Student, New York University, New York, N. Y.

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KARGES, LOUIS, Student, Carnegie Inst. of Technology, Pittsburgh, Pa.

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TURNAU, EDMUND H., Student, New York University, New York, N. Y.

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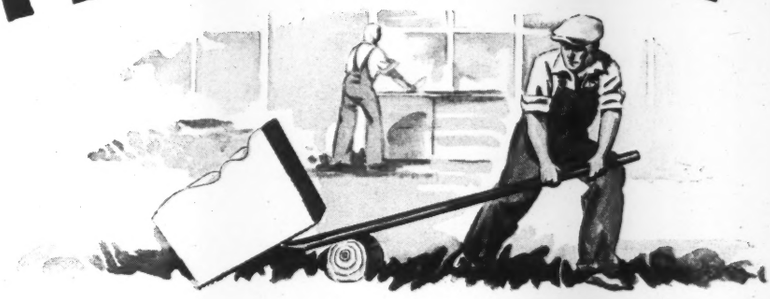
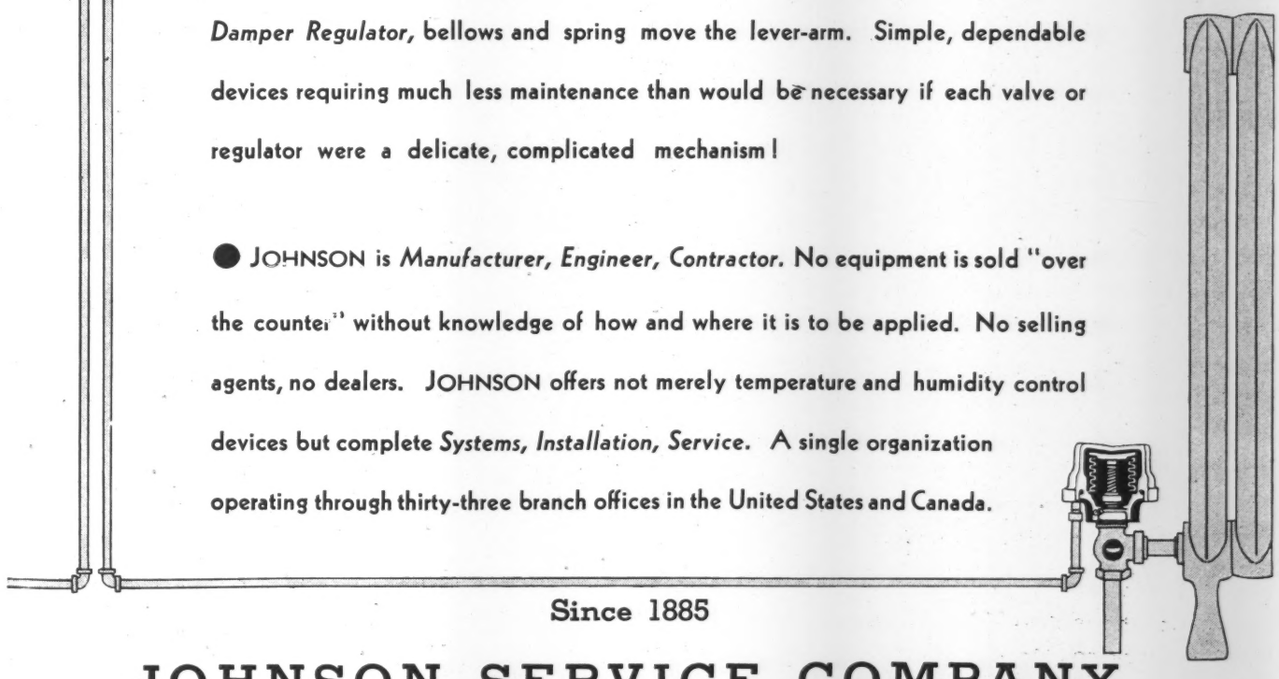
SIMPLICITY



● The JOHNSON *gradual acting Thermostat* is simplicity itself—merely a dependable automatic reducing valve. The accurate, bi-metallic temperature element varies the air pressure on valves and damper regulators, gradually, as more or less heat is required. Jewelled bearings insure that the bi-metallic strip is always free to move as the temperature demands.

● The JOHNSON *Diaphragm Valve* is simple, fool-proof — a seamless metal bellows and heavy spring operate the valve-stem. Similarly, in the JOHNSON *Damper Regulator,* bellows and spring move the lever-arm. Simple, dependable devices requiring much less maintenance than would be necessary if each valve or regulator were a delicate, complicated mechanism!

● JOHNSON is *Manufacturer, Engineer, Contractor.* No equipment is sold "over the counter" without knowledge of how and where it is to be applied. No selling agents, no dealers. JOHNSON offers not merely temperature and humidity control devices but complete *Systems, Installation, Service.* A single organization operating through thirty-three branch offices in the United States and Canada.



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Taylor Forge Ells are correctly designed to minimize unnecessary field work. They present a finished workmanlike appearance with all the lasting qualities which have characterized Byers Genuine Wrought Iron Pipe for the past sixty-nine years.

BYERS GENUINE WROUGHT IRON PRODUCTS

A. M. BYERS COMPANY
Pittsburgh, Pa. · Established 1864

Meets Competition—

(*From page 251, Editorial Section*)

ditioning this commercial building. (The reader will find more detailed descriptions of systems designed on the same principles in the author's articles in the February, 1931, and January, 1932, issues of HEATING, PIPING AND AIR CONDITIONING.)

The operating data for this plant have been carefully and accurately compiled, with complete logs which record information that is necessary to determine what an air-conditioning plant is doing from an investment standpoint. This has been accomplished in the Heard building with very little additional cost and has been most valuable to the owners.

A manometer instrument furnishes readings of all pumping capacities; the current consumptions for the entire air-conditioning system and old washed air system have been separately metered and gages and thermometers have been installed for refrigerating-plant readings. With these devices, the operating logs are made possible.

Connected Motor Load is 190 Hp

The following table gives the area of the air-conditioned spaces and the connected motor horsepower:

Rentable area, air conditioned	57,643 sq ft
Rentable area, supplied by washed air system	10,000 sq ft
Rentable cubic contents supplied by air-conditioning system	590,000 cu ft
Rentable cubic contents supplied by washed air system	115,000 cu ft
Connected horsepower:	
Compressor	100 hp
Air-conditioning fan No. 1	15 hp
Air conditioning fan No. 2	10 hp
Dehumidifier pump No. 1	15 hp
Dehumidifier pump No. 2	10 hp
Well pump	25 hp
Washed air system, including fan and pump	15 hp

Power Cost for 1932 Season

The following are kilowatt-hour consumptions and power costs for the entire 1932 air-conditioning season, based on an average electric rate of 1.88c per kilowatt-hour:

May	8,990 kw hr	$147.70
June	36,280 kw-hr	656.55
July	43,350 kw-hr	766.30
August	45,510 kw-hr	780.80
September	30,300 kw-hr	703.15
October	12,355 kw-hr	266.75
Total	176,785 kw-hr	$3,321.25

These figures include the cost of the washed air system in addition to the air-conditioning system, which is not deducted in the following unit operating and installation costs:

The kilowatt-hours per season per cu ft of rentable area are 0.3. Cost per cu ft of rentable area per season is $0.0056. The kilowatt hours per sq ft of rentable area per season are 3.06. The cost per sq ft of rentable area per season is $0.0577.

Cost of Air Conditioning, $21 per Day

For a season of 158 operating days, the cost of air-conditioning per day is $21.00. It will be noted that in

parts of the months of May and October it apparently was necessary to run only the air circulating system without refrigeration, this being possible due to a low dew-point condition outside and by wasting return air. The plant does not operate at other periods of the year than those listed above.

The cost of operating the plant per ton per season is $22.20. The total connected horsepower per ton of refrigeration is 1.17. Connected refrigerating plant horsepower per ton of refrigeration, including compressor and well pump, is 0.833.

The following figures might be of some interest, but it must be kept in mind that they are based on an air-conditioning plant installed in Phoenix, designed for outside conditions of 105-F dry bulb and 80-F wet bulb with inside conditions of 85-F dry bulb and 69-F wet bulb and would not apply to cities having less severe climatic conditions.

The ratio of tonnage to volume of conditioned space is 1:3915. Average air change in conditioned spaces is 6.2 per hr. Total cost of air-conditioning system per ton of refrigeration is $286.00. Ratio of tonnage to cfm supplied is 1:407.

From the first day of operation, complete operating data were noted on the engineer's plant logs, including all readings of temperatures and quantities that would be of importance in determining the efficiency and results obtained. A copy of this log is reproduced on page 251 and shows the conditions obtained during a typical "air-conditioning day."

This log might seem a bit more elaborate than necessary, but the number and frequency of readings taken reduces the possibility of errors; it is recommended that logs for air-conditioning plants be based on not less than hourly readings.

Referring to the log sheet, clearance pocket capacity control is incorporated in the Heard plant in addition to the usual suction pressure regulation, this plant being operated with a float-control system for liquid feed, making expansion valve adjustment unnecessary and impossible. Gages have been installed on both sides of the suction-pressure throttling valve, which valve is air-operated by a temperature control system so that in any event, this throttling valve will take care of the required capacity regulation. Such regulation is inherently inefficient and consequently whenever the operator of the plant observes that any appreciable amount of throttling has taken place on account of the suction-pressure regulator, he then decreases the amount of compressor displacement by opening one or two clearance pockets as may be required.

The log sheets also serve to indicate whether or not there is sufficient non-condensable gas in the system to justify operation of the purging apparatus, with which the plant is provided and which, if operated properly, results in very considerable reductions in condensing pressure and a consequent reduction in power consumption.

In the economic analysis of this plant, the author has not listed any charges for depreciation, nor has he allowed for any additional cost of operating staff. In this particular case no additional men are needed to operate the air-conditioning plant over the number originally employed.

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Combine Best Fitting Design with Finest Wrought Iron

EVERY Taylor Forge Wrought Iron Welding Ell is made from Byers Genuine Wrought Iron Pipe. The Taylor Forge patented forming and forging process assures a correctly engineered fitting, a fitting that is not only easier to handle, but one that is stronger, too.

Taylor Forge Wrought Iron Welding Ells are smooth inside and out because they are made from pipe, not plate. They are stronger because they are selectively reinforced. To facilitate alignment, tangents are provided. And, to produce a clean weld, the ends are machine beveled. All these advantages are included with no price premium. Write for information and estimating prices.

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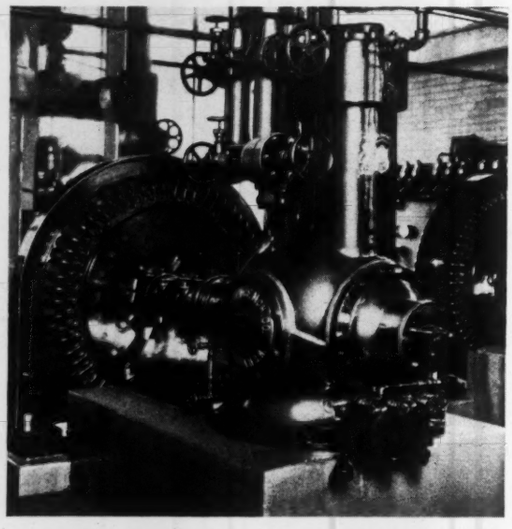
4 ESSENTIALS

to Insure the Success of Your Air Conditioning Installation....



ONE HUNDRED TON BAKER COMPRESSOR DIRECTLY CONNECTED TO SYNCHRONOUS MOTOR

BAKER REFRIGERATION means....

- COOLING POWER—and ability to dehumidify to the exact degree you want.
- FLEXIBILITY—and ease of control by automatic instruments . . . at a worth-while saving in operating costs.
- DEPENDABILITY—backed by Baker's twenty-eight year old record of doing the job right.
- COMPLETENESS—Self-contained Units up to Fifteen Tons . . . Compressors and Condensing Equipment up to any capacity . . . water and brine coolers of any size and type.

Typical Baker Air Conditioning Installation

A Baker self-contained unit keeps this fine restaurant cool and comfortable in summer.

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MANUFACTURING PLANTS:
OMAHA FORT WORTH
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Central Heating—

(*From page* 244, *Editorial Section*)

in place. This material is more porous than the waterproof felt and permits the steam and moisture more readily to escape during the drying period. Laminated covering may be removed and reapplied many times, as it stands handling well. This is not the case with magnesia insulation.

The same class of covering should be carried through the expansion, valve and drainage pits. Removable copper sleeves should wholly encase the expansion joints, and should be insulated the same as the pipes. All valve bodies and flanges should also be insulated.

Keeping Steam on Lines Prolongs Life

The life of both pipe and insulation will, in the author's judgment, be prolonged fully 25 per cent if steam is kept on the underground lines all the time—both summer and winter. Moisture will accumulate on and in the pipes and in the insulation shortly after the steam is shut off, and the whole installation will begin at once to deteriorate.

With proper design and installation, the piping system may be kept hot throughout the year, and should a lighting plant have been installed, the exhaust from the engines will serve equally well.

The expenditure of the small amount of fuel required will prove an excellent insurance and should be carried on the operating expense sheet as such. Of course, if electricity is generated on the premises and usefully employed, it should be credited to the operating account at the same rate as would have to be paid the utility company.

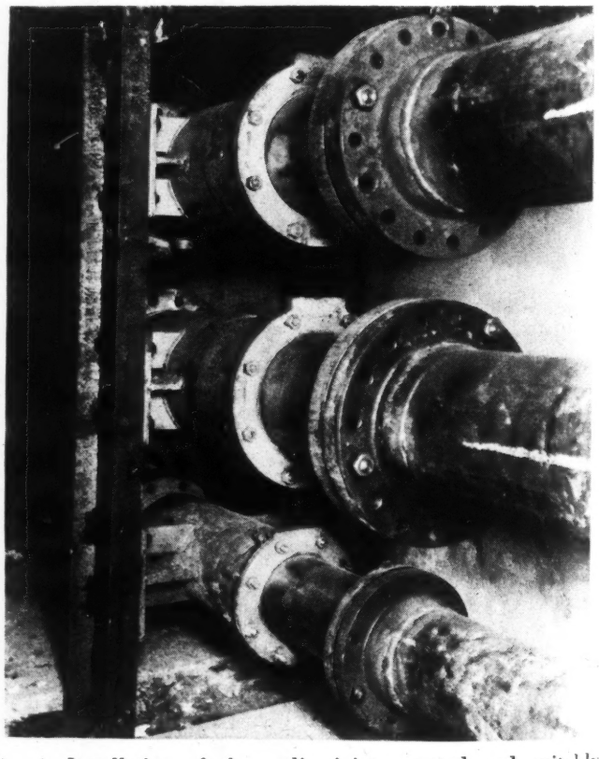

Fig. 4—Installation of three slip joints erected and suitably anchored in a pipe tunnel

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WATER VALVE
FOR AIR
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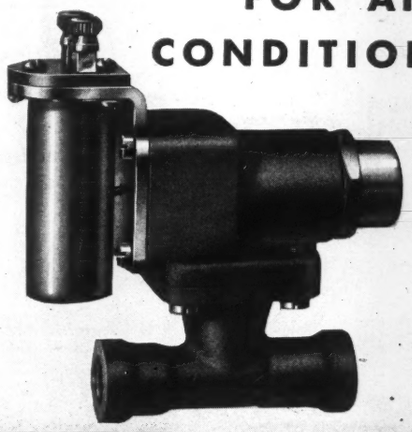
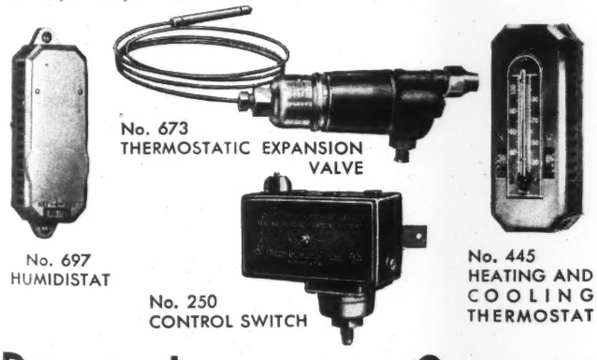


No. 640

"GENUINE DETROIT"
electric water valve

Entirely eliminating any objectionable A. C. hum ...any hammering or jolting in the line...the new No. 640 "Genuine Detroit" Water Valve closes tightly — power both to open and close. It is especially designed for humidity work, but has many uses in other work where a tight, positive valve is required.

This new water valve is one of a complete line of "Genuine Detroit" controls for air conditioning, which includes, with others, the No. 697 Humidistat, No. 673 Thermostatic Expansion Valve, No. 250 Control Switch and No. 445 Heating and Cooling Thermostat. Write today for Bulletins Nos. F-39B, F-51, F-60, F-61.



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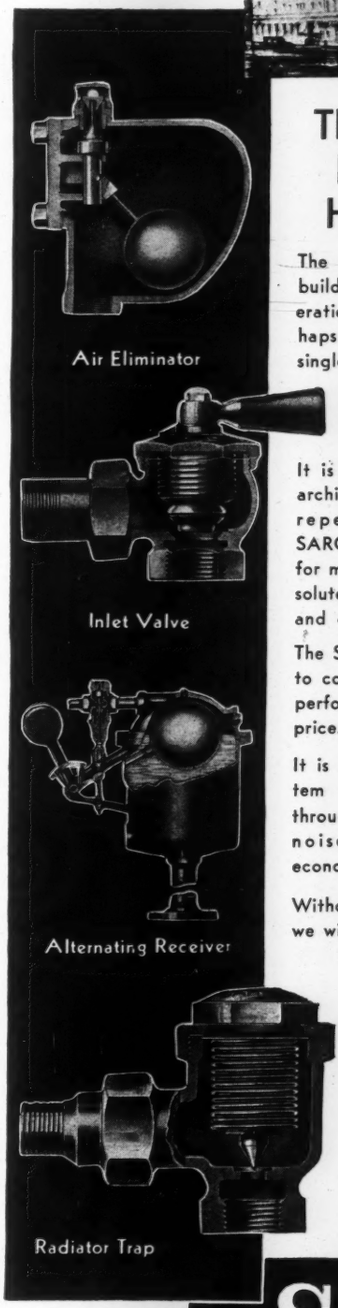

The Heart of the Building is the Heating System

The continued popularity of any building rests on the effective operation of the heating system, perhaps more than on any other single factor. And uniform heating depends on the effective operation of a scientifically designed heating system.

It is for this reason that leading architects and engineers give such repeated preference to the SARCO Heating System, which for many years has proved its absolutely dependable operation and durability.

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It is a quality system through and through. Operates noiselessly and economically.

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CAPACITY *doesn't always depend on* SIZE

IN athletics, it is a rule that "a good, big man is better than a good, little man." Equally true, a big Armstrong trap has more capacity than a little Armstrong trap.

But that's as far as the rule goes. Steam traps of different types cannot be compared by size—either of the complete trap, of the pipe connections, or of the orifice opening. Even between traps of the same size in the inverted bucket type there is a distinct difference in capacity. Armstrong originated the inverted bucket principle and has 20 years' experience in building such traps to the highest standard of efficiency.

Armstrong sales policies give you exact figures on capacity—no generalities, no guesses, no "jokers." Careful comparison is invited. Based on this—as on many other standards of value—your choice will inevitably be Armstrong.

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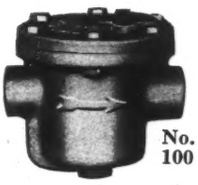
Three Rivers, Michigan



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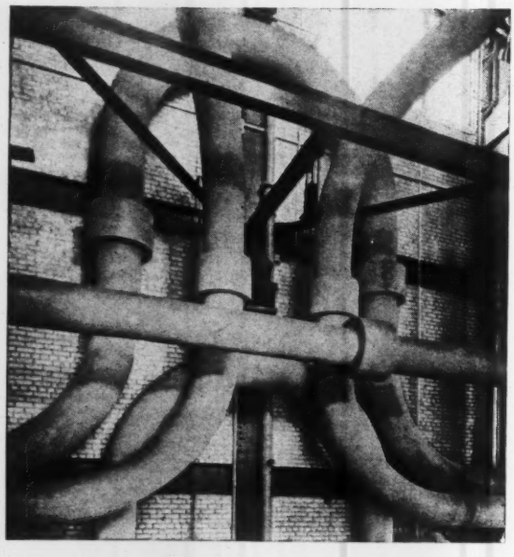

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PITTSBURGH PIPING & EQUIPMENT CO.

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Branch Offices in Principal Cities

Dust Collectors—

(*From page 260, Editorial Section*)

vice according to a definite schedule. If a schedule is not followed regularly damage will be done to the screens. Some systems are operated automatically by time clock. Although this is a step in the right direction, it is not always efficient, as no one can foretell how often or how long to rap screens under varying conditions. Obviously it is useless to rap for long periods with long intervals in between, and it is just as impracticable to rap for short periods with short intervals between. Dust varies with the production in the whole plant and its presence on the screens causes a resistance to the flow of air through them.

Since resistance can be measured easily with a common U-tube manometer containing water, a practical and simple solution of the cleaning problem is to arrange the rapping equipment to start and stop at certain maximum and minimum predetermined air resistances. So far as the writer knows, no such device is on the market now.

Empty Hoppers Regularly

Hoppers are designed to contain a definite quantity of material and if allowed to fill, many of the rapping devices used become buried in the dust. When an attempt is made to operate them the rappers break or twist off, shafts spring out of line, and motors overload and burn out.

Another difficulty is that dust builds up between the screens to such a height that the screen area is materially reduced and, if the dust is damp, the cloth soon rots, holes appear, and dust leaks occur.

Many dusts take on moisture rapidly and often cake and harden so that the difficulty of removing this material is increased if the hoppers are allowed to remain filled. Attendants then may resort to banging the outside of the hoppers, which may dent the inner surface and provide a convenient place for dust to lodge. Hoppers are built with sides having 45- and 60-deg slopes and their selection should depend upon the angle of repose of the dust being handled.

In cold weather, where collectors are placed outdoors, the difference between the temperature of the air being drawn from the building and the outside air is often so great that moisture condenses on the inside of the collector, trickles down into the hoppers and the entire mass of dust freezes. It is therefore advisable to keep such hoppers as free of dust as possible during extreme cold weather.

Disposal of the Dust

When the dust is valueless, the disposal problem is serious. In isolated plants where large amounts of dust are produced, common practice is to fill dump cars which pass under the hoppers and use the refuse as fill. Since it takes some time to load a car under these conditions, dust frequently is allowed to blow around outside of the plant, which is objectionable. In congested districts a truck or trailer having a tight-covered body may be used. This truck is backed up under the hopper, and dust is discharged through canvas chutes into holes in the top of

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YOU paid for heat this winter...in more ways than one. And you'll pay for it this summer, too...when those long stretches of hot, humid weather set in...when the atmosphere in your home approaches the breathless mugginess of the tropics...when dust and dirt sift through open windows...when mental and muscular energy drops and sleepless nights reduce vitality to an even lower degree.

But there's no need to endure these discomforts. York Air Conditioning for the home substitutes clean, filtered, healthful and invigorating indoor air... cooled and dehumidified to the correct degree. Nerves relax in quiet comfort. Sleep is restful and refreshing. Daily tasks seem lighter. Street noises and dirt are shut out. Summer entertaining becomes a pleasure as guests are welcomed across your threshold to the utmost in hospitality...the air conditioned home.

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No *Noise*-- a really QUIET Fan on a SILENT Base

The engineer who is interested in fan performance gets a thrill out of this combination—the new quiet Buffalo "Limit-Load" high-efficiency, non-overloading ventilating fan, mounted on the latest development of Buffalo engineers—the silent, insulated floating fan base (patents applied for).

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"Buffalo" "Limit-Load" Conoidal Fans, *with* Silent Insulated, Floating Base

the truck body cover. In installations where the amount of dust is small, it is collected in ash barrels, which may be made cheaply from oil barrels. The attendants who remove the dust should be provided with efficient respirators and goggles and be compelled to use them at all times, as the conditions under which they work involve heavy dust exposure.

Preventing Water, Air, and Dust Leaks

Leaks may be of three kinds: water, air, and dust. Water leaks are usually due to carelessness in the erection of the dust arrester or piping. As the entire case is under suction when in operation, any loose joint or open seam, or any gasket or bolt omitted, permits water to enter, generally causing the dust inside to cake. All piping seams should be carefully riveted and either soldered or cemented, or welded. Water leaks can be detected when the system is shut down by examining the inside of the case for rust or damp spots around the joints, doors, and pipe openings.

Water falling on the cloth screen causes the dust to harden, reducing the filtering area. This same trouble may be caused by drawing moist air from rooms where steam processes are carried on in the vicinity of the exhaust hoods.

Air leaks generally occur at the following places: (1) Air leaking into ventilating piping at seams and joints produces a loss in suction at the hood. (2) Air leaking into the dust arrester case through improperly-closed hopper discharge valves reduces the suction at the hoods, picks up dust in the hopper, and whirls it around the bottom of the screens causing excessive wear. Leaks from this source can cause damage only when the hoppers are nearly empty and can be detected by the noise of the air rushing in from outside. The presence of whirlpools in the dust side of the arrester and clear spots near the seams indicates air leaks.

Dust leaking through holes in the screens between the dust and clean-air side of the case are shown by the presence of dust in the clean-air side of the arrester. Such leaks must be stopped at once as this dust often passes through the fan and finally back into the building, reducing the efficiency of the system and causing fan wear. If a screen is known to be torn, it may be blocked off temporarily by nailing a piece of canvas backed with wood across the opening over the leak on the clean-air side. This removes the leaky screen from service until repairs or replacements can be made. As was mentioned, the chief cause of dust leaks is the improper rapping of the screens or insufficient care in installing them.

Insuring Long Life of Dust System

Many factors determine the length of life and efficiency of a dust-arrester collecting system and should be carefully considered in the design and erection: among these are screen wear, protection of dust-arrester case, piping, fans and motor, and fire protection.

Causes of Screen Wear

Screen wear may be caused in several ways. If the velocity of the entering dust-laden air is too high, the

heavy dust particles, instead of settling to the bottom of the hopper, are carried along and hit the screens at high velocity. Their abrasive action soon cuts away the cloth at the edges of wooden frames and dust is carried into the clean-air chamber.

Overloading screens because of insufficient filtering area results in rapid plugging and fine dust is pulled through, ruining the screen. When deciding on a dust arrester, it is important that the types considered be judged on the basis of the same number of cubic feet of air handled per square foot of cloth and to see that net, and not gross, screen areas are used in the calculation.

The cloth of which screens are made has been developed and tested by leading manufacturers and presumably is the best that can be secured, although there is wide variation in quality. Many plants attempt to repair worn out screens by using locally-purchased cloth which has the same appearance as the original sample. Frequently cloth not made for the purpose allows fine dust to pass through, or the resistance created to air flow is so great that dust is not collected at the hood.

Baffle plates to deflect dust away from the screens as it enters the case sometimes become loose and drop down or are too small or improperly located, causing the screens to be cut and leaks to develop.

The life of the screens varies considerably with the material handled and the care and attention given them. Some are ruined by neglect in a few days, while others will last for, say, eight years. As they are the most expensive replacement part of a collector system, cleaning should never be neglected and an automatic system of cleaning, as previously described, will prove helpful.

Classifiers Protect Screens

Dust sometimes contains a large percentage of heavy, abrasive material. With this condition a classifier should be placed between the exhaust hood and arrester. This is really a section of a dust-arrester case in which the screens have been replaced by steel baffle plates which are located so as to change the direction of air flow and lower the velocity of the material, causing it to be thrown down into the hopper. The result is that only the lightest of the dust particles are carried to the screens.

Lint and waxy material thrown off from buffing wheels should first pass through a classifier containing baffles of wire screens, which must be cleaned frequently. Sometimes a double system of rapping devices can be arranged so as to rap the bottom and sides of the screens simultaneously. The use of classifiers greatly reduces the wear on the screens by reducing the concentration of dust and increases their life considerably so that, where space and cost permit, they should be used. In handling material of a sticky nature trouble is frequently encountered with screens plugging at high temperatures and therefore the air temperature sometimes must be lowered.

Editor's Note: This article will be concluded next month and will include operation and maintenance pointers concerned with the arrester case, the design of the piping, the fans and motors, and preventing fire in the collection system. A complete summarized inspection schedule will also be presented.

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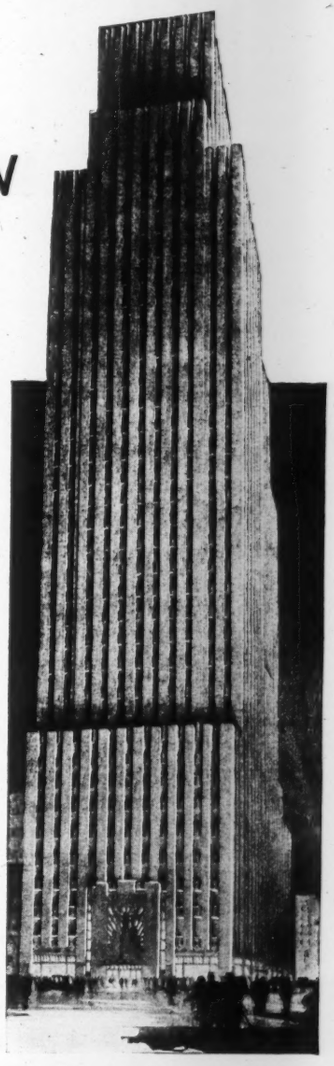

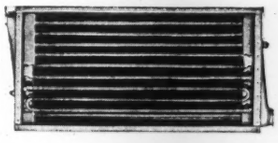

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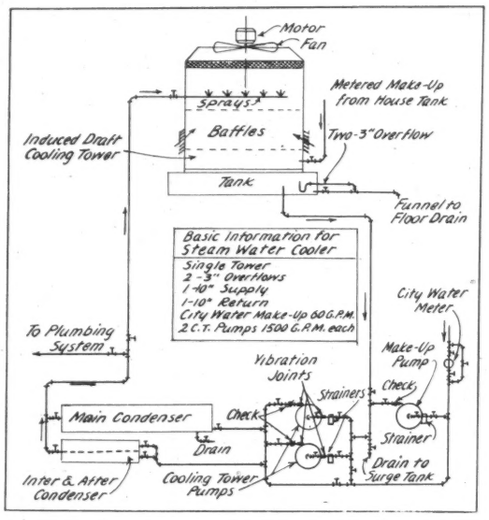
(*From page 241, Editorial Section*)

condensed, are ejected to the sewer by means of a hot-well pump. Incidentally, this is the only moving part of the entire refrigeration system.

Pumping and Controlling the Chilled Water

The chilled water produced by the steam-jet machine is delivered under automatic control to the store and office dehumidifier spray pumps. These pumps are so connected and controlled that they can utilize all or a part of this chilled water or recirculated water, or a mixture of both. This mixture of water in turn chills or tempers the conditioned air, as well as washing and dehumidifying it.

The amount of warm water returned to the cold-water pump is regulated by a weir or dam arrangement constructed within the dehumidifier water-storage tank. The warm water which passes over this weir is returned by gravity to the cold-water sump. A suction line leading from the steam-jet machine is connected with this sump, and the required quantity of water for chilling purposes is thus obtained. With but a slight change in controls, the dehumidifier pumps maintain the necessary humidifying or dehumidifying spray and air-washing features during all seasons. The cold-water pump operates in conjunction with the steam-jet equipment during the dehumidifying seasons only.



Schematic diagram of the condenser water piping for the steam water cooler

Cooling Tower Supplies 5 GPM per Ton

As in other methods of refrigeration or water chilling, the ever-present problem of condenser water remains. With the steam system, it is necessary to extract approximately three times the number of Btu's as with mechanical refrigeration equipment with the condensing

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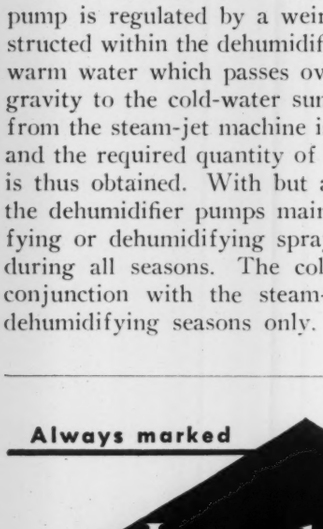

THERE is QUALITY in Fig. 106-A Jenkins Bronze Globe Valve—extra deep stuffing box—slip-on, stay-on disc holder—one-piece screw-over bonnet—Jenkins disc. It pays to insist on Jenkins Valves and the extra service that has characterized Jenkins quality since 1864.

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Fig. 106-A Globe, Screwed

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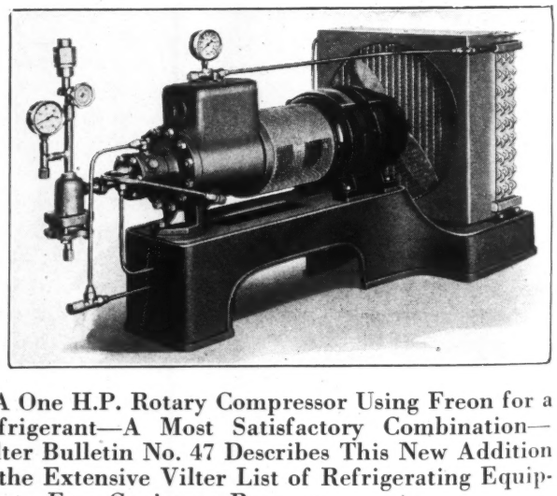

A One H.P. Rotary Compressor Using Freon for a Refrigerant—A Most Satisfactory Combination—Vilter Bulletin No. 47 Describes This New Addition to the Extensive Vilter List of Refrigerating Equipment—Free Copies on Request.

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medium. In order to determine the exact amount of water required, a series of tests were conducted and the results indicated that five gpm per ton was ample; this compares favorably with other forms of refrigeration. A water-cooling range of 20 degrees (from 82 degrees DB to 102 degrees DB) was specified. This is conservative and well within the performance range of modern induced or forced draft, spray-type condenser water cooling equipment.

The tower is constructed entirely of California red fir, with the receiving basin or pan lined with sheet lead. Sufficient baffles and spray or mist eliminators are of course installed. With these precautions and the fact that the tower will operate within a fixed wet-bulb range, the possibility of fogging is practically eliminated.

Both an automatic city water and house tank ball float make-up has been provided, to assure a constant supply of condenser water at all times. Variations in tower loading can be obtained by varying the number of fans operated. Four double-stage disc-type fans are installed, located at the top of the tower, and extending above the roof of the building. The entire cooling tower measures 20′ x 19′ x 22′ high and is housed entirely within the building proper, an advantage from both an architectural and maintenance viewpoint.

"Wet-Bulb Type" of Humidity Control Used

Successful operation of a modern air-conditioning system is dependent upon the proper assembly and installation of temperature and humidity control instruments. Due to the rigid performance guarantees on this job, a special and relatively new wet-bulb type control system is installed. The principal of this system is similar to the dew-point type of control. A feature is the graduated-type thermostat installed in the return air duct. Should the temperature or humidity vary in the conditioned zone, this thermostat will immediately change the air mixtures. With this arrangement the temperature throughout the building is controlled and balanced gradually without excessive temperature surging.

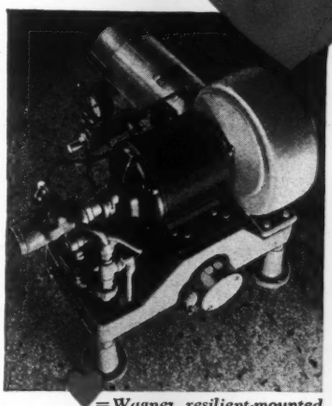
Wet-bulb thermostats installed in the conditioner regulate the dehumidified air temperature and control the operation of the chilled water machine. The action of these thermostats upon the various air motors (pneumatic) controls the operation of all dampers. These, in turn regulate and balance the quantity of fresh and re-used air and its mixing. The system provides a complete change of air every six minutes, insures the correct air pressure balance, and excludes infiltration.

Pipe Shafts Back-Filled Prevent Air Leakage

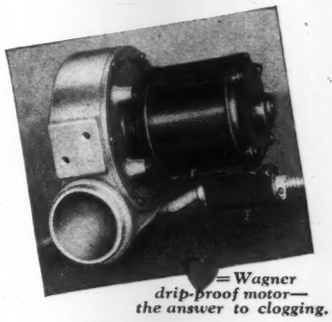
Care has been exercised in back filling all pipe shafts or other openings in the walls, floors or ceilings, so that the entire structure will be reasonably tight. Without these precautions it might be difficult to maintain the desired conditions of comfort economically. The minimum amount of fresh air was determined after a thorough check as to the fresh air required per person from a health and comfort standpoint, and that required to prevent infiltration by the building up of a slight positive pressure.

Recording instruments are installed to record the wet-

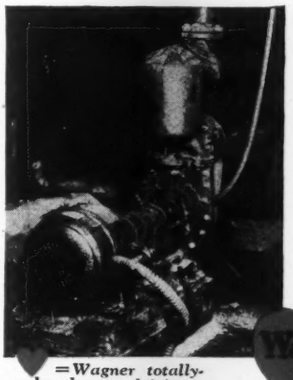
A change of heart solves many a service problem



=Wagner resilient-mounted motor—quiet, vibrationless.



=Wagner drip-proof motor—the answer to clogging.



=Wagner totally-enclosed motor driving a centrifugal pump handling a 27% sulphuric acid solution. This motor is proof against dust, fumes and moisture.

For example, when your customer complains that his motor is too noisy—or sets up objectionable vibrations—put a Wagner resilient-mounted motor on the job, and end the trouble.

Or, when a motor is clogged repeatedly with particles of coal or other dropping solids, replace it with a drip-proof motor whose endplates exclude the cause of the trouble.

Or, when a customer complains that his motor is attacked by corrosive fumes, necessitating frequent rewinding or replacing—put a Wagner totally-enclosed fan-cooled motor on the job—the motor designed for locations where dust, fumes and moisture unfit ordinary open-type motors.

Remember that the heart of any motor-driven machine or appliance is the motor—and that the machine is blamed for the deficiencies of that heart. Your customers buy a machine or an appliance as a complete unit.

Who is to blame if the motor gives trouble? Guilty or not, the manufacturer or dealer of the machine is held responsible by the user. He is expected to avoid such troubles.

Whether it's noise, or vibration, or what not—change to Wagner and end the motor service problems.

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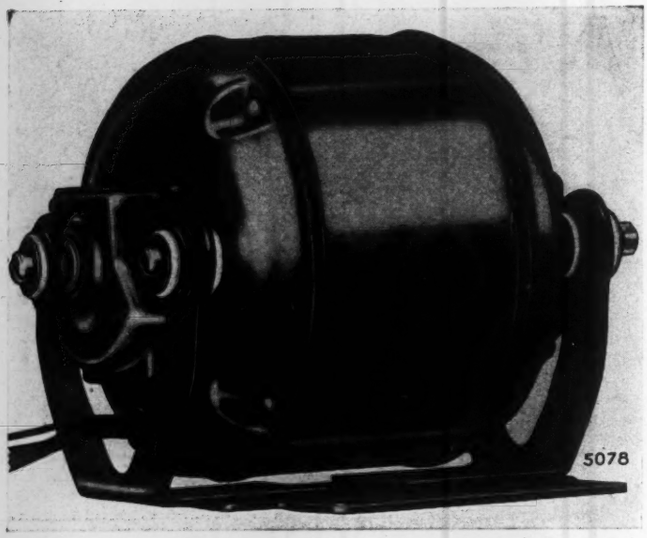

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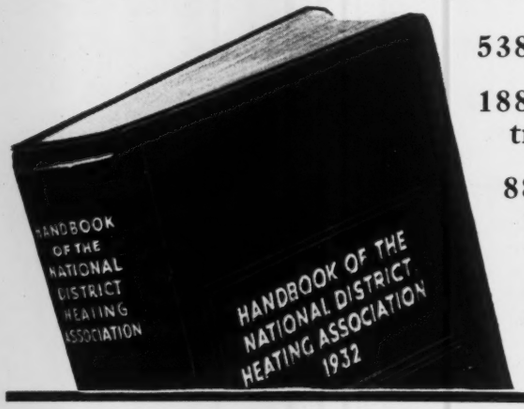

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and dry-bulb temperatures at vital points throughout the system. The entire control system is fully automatic, the only manual operation required being the change in settings of instruments in order to vary indoor conditions during the winter, summer or in mid-seasons. These instruments and charts, properly kept, will prove of great value to the operating engineer when checking the steam, condenser water, and power consumption. From a design point of view, records such as these will also be of value.

Study Made of Operating Hours

A very intensive study was made of the operating wet-bulb hours. It is interesting to note that the tonnage is in direct proportion to the outdoor wet bulb (total heat). In other words, the largest percentage of the refrigeration load is that required in cooling the entering air. The sensible temperature indoors varies through but 15 degrees, 95 to 80 F. The heat from the occupants, lights, sun, etc., was taken into consideration and the refrigeration load calculated. It is interesting to note that six boosters of approximately 17 per cent capacity each are required for the wet-bulb divisions. This arrangement provides for maximum flexibility of operation and economy of steam consumption. The summation of the various wet-bulb data was further used to calculate the probable yearly operating costs and the amount of steam, condenser and chilled water pump power, city water makeup and the total fan power.

Air Distribution to Store Areas

The system of air distribution for the stores consists of a double-duty type air circulator. The basis of the system is the introduction of relatively small quantities of highly cooled conditioned air, at reasonably high entering air velocities. As this air enters the room, it creates an active air circulation within the conditioned space. The air is introduced through a specially designed combination supply outlet and grille, located in the side wall, as close to the ceiling as practical. The return-air grilles are located in the main ceiling adjacent to the supply outlets; this arrangement provides for maximum comfort, and presents an attractive and pleasing architectural treatment.

An added convenience is the individual control of each room or store by easily-operated dampers which can be adjusted so as to vary the temperature to suit the desire of the occupants. This also enables the building manager to close temporarily the conditioned air outlets which deliver air to any unoccupied stores.

Introduction of Air to Offices

In the office section combined independent heating and cooling distributor boxes are installed, which produce the desired conditions as outlined for the store system. They can be manually operated and controlled at will, and possess the added refinements of heating and tempering during the winter season. The units are located under each window from which the conditioned air is discharged vertically. All of the air supplied these units is conveyed through well insulated ducts located between

the windows and extending from the sub-basement to the sixth floor. With this arrangement, valuable floor space is not required for duct shafts. The duct work, located in the outside walls, becomes a part of the building construction and produces a pleasing architectural effect. The return or exhaust air is centrally located at the end of the elevator corridor from which the air is withdrawn from the various offices through indirect doors or small grilles.

All Air Is Filtered

All of the air which enters the conditioned area is thoroughly washed, filtered, and humidified or dehumidified during all seasons. By far the greater portion of the air handled is passed through both the large water-spray type combination air washers. All other air is passed through a double thickness of glass wool filters where entrained dust, soot, etc., is removed. These filters were designed for ample air capacity and possess the desired qualities of simplicity of operation, with ease of replacement and disposal of the used cells.

pH Controller Regulates Neutralizer

A careful study was made on corrosion prevention and ample safety precautions are used. All of the water entering the condenser and chilled water circuit will be treated specially. A unique type of pH controller and recorder will control and regulate the neutralizer, thus reducing the possibility of corrosion.

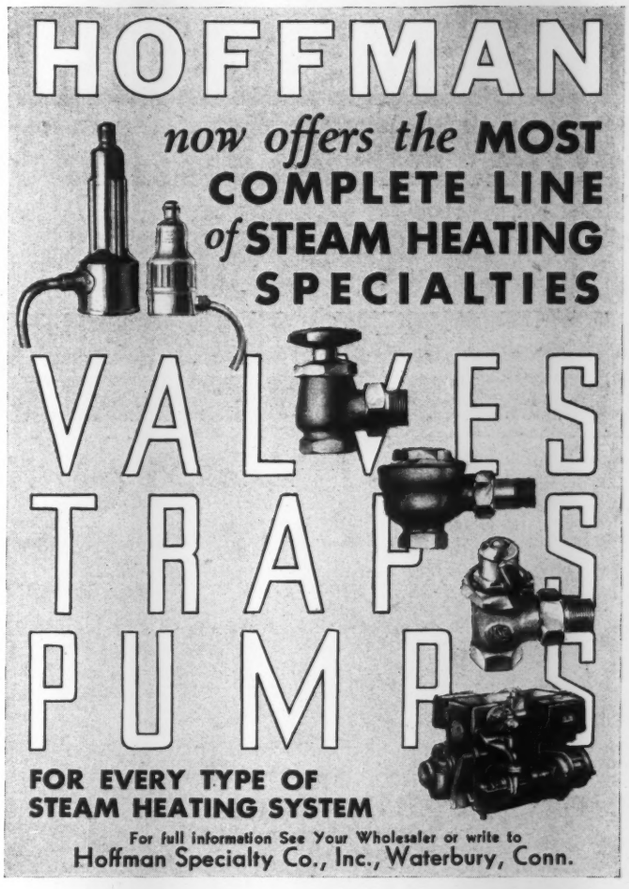
Heat and Sound Insulation Is Complete

All of the ducts located in the basement have been insulated against heat and sound, as have the pumps, fans, dehumidifiers, heaters, condensers, flash tank and cold water piping. Foundations were designed so as to be structurally permanent and are insulated for sound prevention and vibration. All of the mechanical equipment will operate at relatively low speeds and as a further precaution, vibration joints were installed between all pipe work and pumps. Canvas collars separate all duct connections to the various supply fans and the discharges of all fans were lined with a special sound-proofing material.

Ionization Equipment Provided

Complete ionization equipment has been installed in connection with each of the three air-conditioning systems for the prevention and (or) elimination of odors. The equipment is fully automatic and is inter-connected with the various supply fans of each system. With this arrangement the ionization equipment is automatically placed in operation when the fans are running. Should an emergency arise which would necessitate the replacement of a tube, various ionization machines can be disconnected and stopped by means of an easily accessible snap switch.

A new tentative standard grain size chart for the classification of steels has recently been issued by the *American Society for Testing Materials* (E19-33T). Copies are available from the *A.S.T.M.*, 1315 Spruce St., Philadelphia, Pa., at 25c.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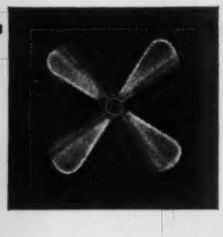
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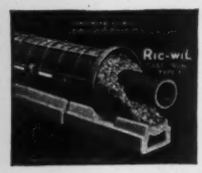

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Equipment—

(*From page* 264, *Editorial Section*)

its normally closed contacts. This relay has a short time delay drop-out which holds the contacts open during the period of acceleration. When the motor reaches a predetermined speed near synchronism, the time interval between half-waves of current is sufficient to allow the relay to drop out and apply field. By a simple adjustment of the relay, its time setting can be varied so that it will apply field at any predetermined speed from 92 to 99 per cent of synchronous speed.

In addition to a means for automatically applying field excitation near synchronism, the new motor controllers are provided with a power-factor field-removal relay which automatically removes field excitation when the motor drops out of synchronism.

These synchronous motor controllers are also provided with a two-element temperature relay for protecting the stator windings and, in addition, a temperature squirrel-cage protective relay is included to protect the amortisseur windings under all operating conditions. A new Telechron motor-operated timing relay is used to initiate the transfer from "starting" to "running" connections on reduced voltage and "part-winding" controllers.

Recent Trade Literature

Air Conditioning for Process: Niagara Blower Company, 673 Ontario St., Buffalo, N. Y. A loose-leaf data book containing rating tables, dimensions, weights, and other useful information on fan coolers, cooling coils and surface, fan heaters, heating sections, booster heaters, air conditioners, etc., for industrial, process, and storage-room air conditioning. The information is specific and arranged logically for the use of the designer.

Air Conditioning for Comfort: Lakeside Company, Hermansville, Mich. Series of five pamphlets discussing the air conditioning of stores, churches and similar structures.

Alloys: Allegheny Steel Company, Brackenridge, Pa. A series of seven new bulletins on the various types of chrome-steel, giving chemical and physical data, information on controlling corrosion, applications, data on resistance to temperature, etc.

Boilers: Arthur J. Herschmann (Agent of Vitkovice Steel Works), 50 Church St., New York City. Folder on modernization of process steam plants with high-pressure and temperature boilers (1900 lb, 932 F).

Beer Meters: Pittsburgh Equitable Meter Co., Pittsburgh, Pa. Data sheet on meters for brewery service, including standard and portable types. A plug valve for brewery service is also described.

Controllers: The Foxboro Company, Foxboro, Mass. Eight-page bulletin describing features, uses, construction, and operation of electrically-operated controllers with rotating contacts

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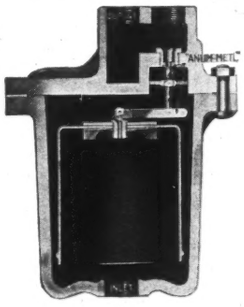

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for temperature, pressure, humidity, level, etc., control and recording.

Equalizing Valves: Gorton Heating Corporation, Cranford, N. J. Four-page price sheet and descriptive folder on equalizing valves and single-pipe vapor-heating systems.

Gears: The Strong, Carlisle & Hammond Co., 1392 W. Third St., Cleveland, Ohio. Folder illustrating chain drives, gears of various types, speed reducers, shaft supports, pulleys and pillow blocks, couplings and bearings, available from stock.

Heaters: Commodore Heaters Corp., 11 W. 42nd St., New York City. Four-page bulletin of tables giving performance of convector heaters; one set shows actual condensation or steam consumption in Btu's per hr in compliance with *A.S.H.V.E.* code and the other set effective heating capacities to aid in selection.

Insulation: The Standard Lime & Stone Co., Baltimore, Md. 4-p. bulletin on rock wool pipe coverings, canvas covered and water-proofed types for insulation of hot and cold water, low-pressure and superheated steam, ice water and refrigeration lines, etc., from —60 to 1250 F; features, specifications, and prices. 8-p. bulletin on rock wool felted insulating blankets for boilers, tanks, dryers, stills, ducts and breeching, etc., 30 to 1250 F; several styles for various uses; table of heat losses, thickness, weights. 4-p. bulletin on rock wool insulating cements, high- and low-temperature types.

Iron: Republic Steel Corporation, Republic Building, Youngstown, Ohio. Twelve-page booklet of the properties of Toncan iron, describing not only the properties of this metal but their importance.

Modernization: Crane Company, 836 S. Michigan Ave., Chicago, Ill. Twelve-page booklet calling attention to the existence of waste in industrial plants due to old age or obsolescence. Also a twelve-page booklet containing seventeen check-points showing a practical way to apply an efficiency viewpoint to piping equipment in industrial plants. These two booklets (with inserts showing modern piping equipment) are part of a recently-initiated program stressing the need for modernization of industrial piping and presenting helpful information on how such modernization may be accomplished to the benefit of production costs.

Piping: Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill. Eight-page pamphlet on flow test data and strength analysis of welded piping. Importance of proper design for welded piping is stressed, results of a test on the friction caused by various types of elbow are presented, and bursting stresses are discussed.

Pipe Compounds: Technical Products Company, Pittsburgh, Pa. Six-page folder listing prices and features of various compounds for fitting pipe.

Smoke Stacks: A. M. Byers Company, Pittsburgh, Pa. Sixteen-page looseleaf mimeographed recommended standard specifications for genuine wrought-iron smoke stacks, covering design and construction in detail.

Venting Valves: Hoffman Specialty Company, Inc., Waterbury, Conn. Twelve-page catalog of venting valves for one- and two-pipe steam heating systems, one-pipe vacuum and air-line systems. The various types are described and illustrated carefully and the method of installation is outlined.

Water Heating: Excelso Products Corp., 65 Clyde Ave., Buffalo, N. Y. Folder containing useful information on the installation of indirect water heaters and describing single-coil, double-coil, triple-coil, and dual-coil types. Eleven diagrams show various kinds of installations, and installation suggestions are given.

Wrought Iron: A. M. Byers Company, Clark Building, Pittsburgh, Pa. Sixteen-page booklet describing the methods employed by this company in the manufacture of wroght iron, well illustrated.

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